APPENDIX 5A

System Impact Study

AES Pacific, Inc.
AES HIGHGROVE PROJECT

SYSTEM IMPACT STUDY

April 18, 2005

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL[SM] Company

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SOUTHERN CALIFORNIA EDISON COMPANY

EXECUTIVE SUMMARY

AES Pacific, Inc. ("AES") applied to Southern California Edison ("SCE") for distribution service under the terms of SCE's Wholesale Distribution Access Tariff ("WDAT"). AES will own and operate a 300 MW generating facility ("AES Highgrove") to be interconnected at SCE's Highgrove Substation. Distribution service pursuant to the WDAT is proposed to be from SCE's 115 kV Highgrove Substation to the California Independent System Operator ("ISO") grid at SCE's 230 kV Vista Substation. The proposed in-service date of AES's Highgrove Plant is May 2007.

The AES Highgrove Plant is a generation system consisting of three (3) 100 MW Brush Electrical Machines Ltd. Gas Turbine Generators, with a net generation export of 300 MW. As requested by AES, SCE performed a System Impact Study to identify the general electrical system impacts of the AES Highgrove Plant and possible mitigation measures to maintain conformance with SCE, ISO, or other applicable reliability planning criteria.

The study consisted of a power flow analysis and a short circuit duty analysis (Phase I study scope) to determine whether the energy associated with AES's Highgrove Plant can be transmitted through SCE's distribution system to the ISO grid at Vista Substation, without creating the need for modifications to SCE's distribution system and/or the ISO grid. The study showed that, with the AES Highgrove Plant on-line:

- Thermal loadings on the SCE facilities used to provide the requested distribution service are all within criteria limits.
- Three-phase short-circuit duties increase by 0.1 kA or more at ten (10) 115 kV buses, eighteen (18) 230 kV buses, and five (5) 500 kV buses that have duty levels above 60% of their nameplate three-phase ratings.
- Single line-to-ground short-circuit duties increase by 0.1 kA or more at five (5) 115 kV bus that have duty levels above 60% of their nameplate single line-to-ground ratings. The evaluation of the single line-to-ground duty increases for the 230 kV and 500 kV buses will be conducted as part of the Facilities Study.

Based on these results, SCE concludes that a Facilities Study will be required to evaluate the need for circuit breaker replacements at the 115 kV, 230 kV, and 500 kV levels as a result of the AE Highgrove Plant. The Facilities Study should include the following scope:

- Evaluate the need for circuit breaker replacement and develop detailed costs for any identified breaker replacement at the following ten (10) 115 kV buses, eighteen (18) 230 kV buses, and five (5) 500 kV buses where the AES Highgrove Plant increases three-phase short-circuit duties by 0.1 kA or more and where duty levels are above 60% of three-phase ratings:
  - Devers 500 kV
  - Lugo 500 kV
  - Miraloma 500 kV
  - Serrano 500 kV

- Stagecoach 500 kV
- Barre 230 kV
- Chino 230 kV
- Del Amo 230 kV
- Devers 230 kV
- Etiwanda 230 kV
- Huntington Beach B 230 kV
- La Fresa 230 kV
- Lugo 230 kV
- Mira Loma E 230 kV
- Mira Loma W 230 kV
- Olinda 230 kV
- Padua 230 kV
- San Onofre 230 kV
- San Bernardino 230 kV
- Serrano 230 kV
- Stagecoach 230 kV
- Villa Park 230 kV
- Vista 230 kV
- Altwind 115 kV
- Calectric 115 kV
- Highgrove 115 kV
- Homart 115 kV
- Pepper 115 kV
- Shandin 115 kV
- Vista 115 kV
- Devil Canyon 115 kV
- Mojave Siphon (Cdwr) 115 kV
- San Benardino 115 kV

- Evaluate the need for circuit breaker replacement and develop detailed costs for any identified breaker replacement at the following five (5) 115 kV substations where the AES Highgrove Plant increases single line-to-ground short-circuit duties by 0.1 kA or more and where duty levels are above 60% of single line-to-ground ratings:

    - Calectric 115 kV
    - Highgrove 115 kV
    - Shandin 115 kV
    - San Bernardino 115 kV
    - Vista 115 kV

- The evaluation of the single line-to-ground duty increases for the 230 kV and 500 kV buses will be conducted as part of the Facilities Study.

Preliminary cost estimates to replace all of the circuit breakers at the identified substations are included in Table 1 and Table 2 of this System Impact Study. Detailed costs will be developed in the Facilities Study.

Phase II of this System Impact Study (i.e., stability study and post-transient voltage study) will not be required unless requested by a third party.

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CALIFORNIA PORTLAND CEMENT COMPANY
SYSTEM IMPACT STUDY

March 31, 2005

1. INTRODUCTION

AES Pacific, Inc. ("AES") applied to Southern California Edison ("SCE") for distribution service under the terms of SCE's Wholesale Distribution Access Tariff ("WDAT"). AES will own and operate a 300 MW generating facility ("AES Highgrove") to be interconnected at SCE's Highgrove Substation. Distribution service pursuant to the WDAT is proposed to be from SCE's 115 kV Highgrove Substation to the California Independent System Operator ("ISO") grid at SCE's 230 kV Vista Substation. The proposed in-service date of AES's Highgrove Plant is May 2007.

The AES Highgrove Plant is a generation system consisting of three (3) 100 MW Brush Electrical Machines Ltd. Gas Turbine Generators, with a net generation export of 300 MW. As requested by AES, SCE performed a System Impact Study to identify the general electrical system impacts of the AES Highgrove Plant and possible mitigation measures to maintain conformance with SCE, ISO, or other applicable reliability planning criteria.

The study consisted of a power flow analysis and a short circuit duty analysis (Phase I study scope) to determine whether the energy associated with the AES Highgrove Plant can be transmitted through SCE's distribution system to the ISO grid at Vista Substation, without creating the need for modifications to SCE's distribution system and/or the ISO grid. This report describes the study conditions and assumptions and presents the results of the power flow and short circuit duty analyses. Based on these results, the report concludes that a Facilities Study will be required to evaluate the need for circuit breaker replacements at the 115 kV and 230 kV levels as a result of the AES Highgrove Plant. Phase II of this System Impact Study (i.e., stability study and post-transient voltage study) will not be required unless requested by a third party.

2. STUDY CONDITIONS AND METHODOLOGY

A. Planning Criteria

The study was conducted by applying SCE's planning criteria to the SCE facilities used to provide the requested distribution service. Specifically, the main criteria applicable to this study are as follows:

Power Flow Criteria

Line loading should not exceed 100% of a conductor's thermal rating with all facilities in service (base case).

Line loading should not exceed 135% of a conductor's thermal rating with one line out of service (N-1).

Short-Circuit Duty Criteria

Short-circuit duty should not exceed a circuit breaker's interrupting capability with maximum area generation on-line.

B. System Load Conditions

The study considered three system load conditions: peak loads, light loads, and very light load or evening loads. The peak load forecast was based on SCE's 2005-2014 Distribution Substation Plan. The light load forecast was assumed to be 50% of the peak load forecast and the very light load was assumed to be 35% of the peak load forecast. Two scenarios were considered for each load condition, the first scenario was the 2007 Vista system configuration and the second scenario was the 2009 Vista system configuration.

C. Power Flow Study

This study evaluated AES Highgrove Plant's impact on line loadings for base case and N-1 conditions. Line loadings were monitored both with and without the AES Highgrove Plant to determine if the addition of the Highgrove Plant causes any violations of SCE's thermal loading criteria.

D. Short-Circuit Duty Study

This study evaluated the AES Highgrove Plant's impact on short-circuit duties seen by substation circuit breakers at the 115 kV, 230 kV, and 500kV levels. Symmetrical three-phase fault currents and single line-to-ground fault currents were calculated both with and without the AES Highgrove Plant to determine if the addition of the AES Highgrove Plant causes any violations of SCE's short-circuit duty criteria.

The dataset used for the short-circuit study represented all existing generation and all projects in the queue (up to and including the AES Highgrove Plant) as on-line. Substations where the AES Highgrove Plant increases three-phase short-circuit duties by 0.1 kA or more and where duty levels are above 60% of circuit breaker nameplate three-phase ratings were identified for a more detailed review of asymmetrical duties in the Facilities Study. Similarly, substations where the AES Highgrove Plant increases single line-to-ground short-circuit duties by 0.1 kA or more and where duty levels are above 60% of circuit breaker nameplate single line-to-ground ratings were identified for a more detailed review of asymmetrical duties in the Facilities Study.

3. DISCUSSION OF STUDY RESULTS

A. Power Flow Study

For peak load, light load and very light load conditions for both the 2007 and 2009 Vista system configurations, the addition of the AES Highgrove Plant causes no violations of SCE's thermal loading criteria to the Vista 115kV system.

The AES Highgrove Plant has the largest incremental impact on thermal loading of SCE's two Vista-Highgrove 115 kV lines. These two 115 kV lines along with four others are used to provide subtransmission service to the Highgrove facility. For peak load, light load and very light load conditions for the 2007 scenario, the addition of the Project *decreases* thermal loading on these lines by about 20-25 MW each, due to power being exported from Highgrove once the AES Highgrove plant is on-line rather than being imported. Thermal loading on the remaining lines in the Vista 115 kV system are relatively unchanged with the addition of the AES Highgrove Plant for the 2007 scenarios.

For the 2009 Vista system configuration scenario the AES Highgrove Plant has the largest incremental impact on thermal loading of SCE's two Vista-Highgrove 115 kV lines. For peak load condition for the 2009 scenario, the addition of the Project *decreases* thermal loading on these lines by about 30 MW each, due to power being exported from Highgrove once the AES Highgrove plant is on-line rather than being imported. For the light load and very light load conditions for the 2009 scenario, the addition of the Project *increases* thermal loading on these lines by about 45-70 MW each, due to power being exported from Highgrove once the AES Highgrove plant is on-line rather than being imported. Thermal loading on the remaining lines in the Vista 115 kV system are relatively unchanged with the addition of the AES Highgrove Plant for the 2009 scenarios.

B. Short-Circuit Duty Study

Table 1 summarizes the impact of the Highgrove Plant on symmetrical three-phase short-circuit duties and X/R ratios at various 115 kV and 230 kV buses on the SCE system. Ten (10) 115 kV buses, eighteen (18) 230 kV buses, and five (5) 500 kV buses were identified for which the Project increases three-phase duties by 0.1 kA or more and where duty levels are above 60% of nameplate three-phase ratings:

- Devers 500 kV
- Lugo 500 kV
- Miraloma 500 kV
- Serrano 500 kV
- Stagecoach 500 kV
- Barre 230 kV
- Chino 230 kV
- Del Amo 230 kV
- Devers 230 kV
- Etiwanda 230 kV
- Huntington Beach B 230 kV
- La Fresa 230 kV
- Lugo 230 kV
- Mira Loma E 230 kV
- Mira Loma W 230 kV
- Olinda 230 kV
- Padua 230 kV
- San Onofre 230 kV
- San Bernardino 230 kV
- Serrano 230 kV
- Stagecoach 230 kV
- Villa Park 230 kV
- Vista 230 kV
- Altwind 115 kV
- Calectric 115 kV
- Highgrove 115 kV
- Homart 115 kV
- Pepper 115 kV
- Shandin 115 kV
- Vista 115 kV

- o Devil Canyon 115 kV
- o Mojave Siphon (Cdwr) 115 kV
- o San Benardino 115 kV

Table 2 summarizes the impact of the Highgrove Plant on symmetrical single line-to-ground short-circuit duties and X/R ratios at various 115 kV buses on the SCE system. Four (4) 115 kV substations were identified for which the Project increases three-phase duties by 0.1 kA or more and where duty levels are above 60% of nameplate single line-to-ground ratings:

- o Calectric 115 kV
- o Highgrove 115 kV
- o Shandin 115 kV
- o San Bernardino 115 kV

The evaluation of the single line-to-ground duty increases for the 230 kV and 500 kV buses will be conducted as part of the Facilities Study.

A more detailed review of asymmetrical duties and circuit breaker interrupting capabilities at these substations will be required in the Facilities Study to evaluate the need for circuit breaker replacements as a result of the AES Highgrove Plant.

4. CONCLUSIONS

The results of this System Impact Study showed that, with the Highgrove Plant on-line:

- Thermal loadings on the SCE facilities used to provide the requested distribution service are all within criteria limits.
- Three-phase short-circuit duties increase by 0.1 kA or more at ten (10) 115 kV buses, eighteen (18) 230 kV buses, and five (5) 500 kV buses that have duty levels above 60% of their nameplate three-phase ratings.
- Single line-to-ground short-circuit duties increase by 0.1 kA or more at five (5) 115 kV bus that have duty levels above 60% of their nameplate single line-to-ground ratings. The evaluation of the single line-to-ground duty increases for the 230 kV and 500 kV buses will be conducted as part of the Facilities Study.

Based on these results, SCE concludes that a Facilities Study will be required to evaluate the need for circuit breaker replacements at the 115 kV, 230 kV, and 500 kV levels as a result of the AE Highgrove Plant. The Facilities Study should include the following scope:

- Evaluate the need for circuit breaker replacement and develop detailed costs for any identified breaker replacement at the following ten (10) 115 kV buses, eighteen (18) 230 kV buses, and five (5) 500 kV buses where the AES Highgrove Plant increases three-phase short-circuit duties by 0.1 kA or more and where duty levels are above 60% of three-phase ratings:
    - o Devers 500 kV
    - o Lugo 500 kV
    - o Miraloma 500 kV
    - o Serrano 500 kV
    - o Stagecoach 500 kV
    - o Barre 230 kV

- Chino 230 kV
- Del Amo 230 kV
- Devers 230 kV
- Etiwanda 230 kV
- Huntington Beach B 230 kV
- La Fresa 230 kV
- Lugo 230 kV
- Mira Loma E 230 kV
- Mira Loma W 230 kV
- Olinda 230 kV
- Padua 230 kV
- San Onofre 230 kV
- San Bernardino 230 kV
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- Villa Park 230 kV
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- Altwind 115 kV
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- Homart 115 kV
- Pepper 115 kV
- Shandin 115 kV
- Vista 115 kV
- Devil Canyon 115 kV
- Mojave Siphon (Cdwr) 115 kV
- San Benardino 115 kV

- Evaluate the need for circuit breaker replacement and develop detailed costs for any identified breaker replacement at the following five (5) 115 kV substations where the AES Highgrove Plant increases single line-to-ground short-circuit duties by 0.1 kA or more and where duty levels are above 60% of single line-to-ground ratings:

    - Calectric 115 kV
    - Highgrove 115 kV
    - Shandin 115 kV
    - San Bernardino 115 kV
    - Vista 115 kV

Preliminary cost estimates to replace all of the circuit breakers at the identified substations are included in Table 1 and Table 2 of this System Impact Study. Detailed costs will be developed in the Facilities Study.

Phase II of this System Impact Study (i.e., stability study and post-transient voltage study) will not be required unless requested by a third party.

TABLE 1
THREE-PHASE SHORT-CIRCUIT DUTY SUMMARY

Substation Bus	Minimum CB Rating (kA)	Before AES Highgrove Project		After AES Highgrove Project		Delta kA	# of Breakers at Substation	Estimated Cost Per Breaker ($M)	Estimated Cost ($M)
		Three-Phase Duty (kA)	X/R Ratio	Three-Phase Duty (kA)	X/R Ratio				
Devers 500 kV	40.0	24.0	16.5	24.1	16.6	0.1	3	$2.20	$6.60
Lugo 500 kV	37.8	43.9*	21.7	44.1	21.7	0.2	12	$2.20	$26.40
Miraloma 500 kV	38.4	33.4	24.4	33.6	24.6	0.2	10	$2.20	$22.00
Serrano 500 kV	40.0	29.9	24.3	30.0	24.3	0.1	9	$2.20	$19.80
Stagecoach 500 kV	N/A	26.1	27.9	26.2	28.0	0.1	8	$2.20	$17.60
Barre 230 kV	45.6	49.3*	18.7	49.4	18.7	0.1	16	$0.45	$7.20
Chino 230 kV	50.0	47.9	17.1	48.2	17.0	0.3	9	$0.45	$4.05
Del Amo 230 kV	50.0	41.1	16.0	41.2	16.0	0.1	10	$0.45	$4.50
Devers 230 kV	33.0	44.9*	21.2	45.1	21.1	0.2	13	$0.45	$5.85
Etiwanda 230 kV	34.0	57.1*	25.6	57.7	25.9	0.6	14	$0.45	$6.30
Huntington Beach B 230 kV	37.7	30.1	14.8	30.2	14.7	0.1	4	$0.45	$1.80
La Fresa 230 kV	45.6	46.3*	26.5	46.4	26.5	0.1	20	$0.45	$9.00
Lugo 230 kV	50.0	36.7	30.8	36.8	30.9	0.1	12	$0.45	$5.40
Mira Loma E 230 kV	63.0	59.4	23.2	60.0	23.2	0.6	17	$0.45	$7.65
Mira Loma W 230 kV	63.0	50.2	20.3	50.6	20.3	0.4	12	$0.45	$5.40
Olinda 230 kV	37.7	27.1	13.9	27.2	13.9	0.1	9	$0.45	$4.05
Padua 230 kV	25.1	20.6	15.3	20.7	15.3	0.1	5	$0.45	$2.25
San Onofre 230 kV	50.0	48.8	26.2	48.9	26.2	0.1	26	$0.45	$11.70
San Bernardino 230 kV	50.0	39.6	21.0	40.1	21.0	0.5	11	$0.45	$4.95
Serrano 230 kV	63.0	52.7	24.4	52.9	24.4	0.2	14	$0.45	$6.30
Stagecoach 230 kV	N/A	57.2	26.1	57.8	26.1	0.6	12	$0.45	$5.40
Villa Park 230 kV	50.0	46.2	21.8	46.3	21.9	0.1	9	$0.45	$4.05
Vista 230 kV	40.0	48.0*	19.1	50.0	19.9	2.0	22	$0.45	$9.90
Altwind 115 kV	N/A	12.9	10.6	13.0	10.6	0.1	1	$0.30	$0.30
Calectric 115 kV	25.1	16.4	7.4	21.8	7.3	5.5	14	$0.30	$4.20
Highgrove 115 kV	17.6	17.0	9.1	26.3	14.1	9.3	12	$0.30	$3.60
Homart 115 kV	25.1	12.6	6.1	15.7	5.8	3.0	3	$0.30	$0.90
Pepper 115 kV	25.1	12.3	5.4	15.5	5.1	3.2	3	$0.30	$0.90
Shandin 115 kV	25.1	14.3	6.2	17.2	5.4	3.0	5	$0.30	$1.50
Vista 115 kV	25.1	19.3	11.7	27.4	16.1	8.1	10	$0.30	$3.00
Devil Canyon 115 kV	N/A	12.8	7.0	15.1	6.3	2.2	4	$0.30	$1.20
Mojave Siphon (Cdwr) 115 kV	N/A	5.7	3.3	5.9	3.1	0.2	2	$0.30	$0.60
San Benardino 115 kV	25.1	12.3	6.0	15.2	5.7	2.9	11	$0.30	$3.30

* Pre-project criteria violation due to prior generation projects in the queue.

TABLE 2
SINGLE LINE-TO-GROUND (SLG) SHORT-CIRCUIT DUTY SUMMARY

Substation Bus	Minimum CB Rating (kA)	Before AES Highgrove Project		After AES Highgrove Project		Delta kA	# of Breakers at Substation	Estimated Cost Per Breaker ($M)	Estimated Cost ($M)
		SLG Duty (kA)	X/R Ratio	SLG Duty (kA)	X/R Ratio				
Calectric 115 kV	25.1	18.1	7.4	22.1	7.3	4.0	14	$0.3	$4.2
Highgrove 115 kV	17.6	21.0	9.1	29.3	14.1	8.3	12	$0.3	$3.6
Shandin 115 kV	25.1	15.2	6.2	17.2	5.4	2.0	5	$0.3	$1.5
Vista 115 kV	25.1	22.3	12.6	28.6	12.6	6.3	10	$0.3	$3.0
San Benardino 115 kV	25.1	13.4	6.0	15.4	5.7	2.0	11	$0.3	$3.3

* Pre-project criteria violation due to prior generation projects in the queue.

AES HIGHGROVE PROJECT
GENERATION INTERCONNECTION

SYSTEM IMPACT STUDY
TRANSMISSION ASSESSMENT

April 7, 2005

SOUTHERN CALIFORNIA
EDISON®

Prepared by

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AES HIGHGROVE PROJECT
SYSTEM IMPACT STUDY - TRANSMISSION ASSESSMENT

EXECUTIVE SUMMARY

The AES Corporation applied to the California Independent System Operator (CAISO) for Interconnection. The AES Corporation proposed to interconnect three gas turbine generators, each with a maximum operating rating at 108.19 MW. The generator auxiliary load is 1 MW and net capacity of the project is rated at 323.57 MW. The AES Corporation proposed to interconnect the project ("AES Highgrove Project") to the 115-kV bus at SCE's Highgrove Substation. The in-service date proposed by AES is January 1, 2007.

Southern California Edison's (SCE's) Transmission and Interconnection Planning (TIP) department has performed a System Impact Study to determine the adequacy of SCE's transmission system to accommodate the AES Highgrove Project. The study indicates that the system is not adequate to accommodate the 323.57 MW of generation without modifications. A Facilities Study will be required for the AES Highgrove Project.

The results of the System Impact Study will be used as the basis to determine project cost allocation for facility upgrades in the Facilities Study. ***The study accuracy and the results for the assessment of the system adequacy are contingent on the accuracy of the technical data provided by the AES Corporation.*** Any changes from the attached data could void the study results.

SCE's Field Engineering department has performed a System Impact Study on the SCE affected distribution network.

POWER FLOW STUDY RESULTS

The power flow study results show that overloading problems are found on several transmission lines for base-case, single and double contingencies. Specifically:

Base case

Under spring conditions, the project increased prior base case overloads from 113% to 114% on the Devers – Valley 500 kV line causing a net 1% increase.

Under summer conditions there were no base case overloads

Single Contingency

Single contingency overload problems are found on a total of six transmission lines. Under spring conditions, the Etiwanda – Vista 230 kV line was overloaded from 90% - 97% to 103% - 107% of the nominal rating. Prior overloads on the other lines were increased from 104% - 135% to 100% - 140% of the nominal ratings of the lines.

Under summer conditions, the project increased prior overloads on the Devers – Valley 500 kV line ranging from 100 – 102% to 102% - 104 %.

Double Contingency

Double contingency overload problems are found on a total of five transmission lines. Under spring conditions, the project overloaded the Serrano – Valley 500 kV line from 90% to 101% of its nominal rating for one double contingency. Also, the project overloaded the Etiwanda – Vista 230 kV line from 96% - 135% to 110% - 150%of its nominal rating. The project increased prior overloads on the rest of the lines from 105% - 163% to 110% - 175%. In particular, the project increased a prior overload on the San Bernardino – Vista 230 kV line from 163% to 175% - which is in excess of the line's N-2 conductor rating..

Under summer conditions, the Devers – Valley 500 kV line was overloaded from 103% - 106% to 105% - 108% of its nominal rating.

Most overloads were due to the existing wave trap limitations and other limitations on the GIS line terminals located at Valley Substation. The exception is the San Bernardino – Vista 230 kV line, where overloads exceeded the N-2 emergency limit on the line conductor.

TRANSIENT STABILITY STUDY RESULTS

No transient stability voltage violations were found with the addition of the AES Highgrove Project.

SHORT CIRCUIT DUTY STUDY

The data provided by the AES Corporation has been used to study the Short Circuit Duty contribution. The addition of the Project has impacted 17 substations with increases in the short circuit duty. These impacts require further study to determine the need for circuit breaker upgrades.

SCOPE OF WORK

The scope of upgrades to accommodate the generation interconnection on the SCE network is listed below. This study has not assumed overload mitigation requirements for projects ahead of the queue.

- Upgrades of the 3000A wave traps and line terminals at Valley Substation 4000A on the Devers – Valley 500 kV line.
- Upgrades of line terminals at Serrano & Valley substations on the Serrano - Valley 500 kV line.
- Upgrades of line terminals at Vista and San Bernardino substations on the Vista – San Bernardino 230 kV line from 2300A to 3000A (or greater) line terminals.

- Upgrades of line terminals at Vista Substation on the Etiwanda and Mira Loma #1 230 kV lines
- Upgrade of line terminals at Barre & Lewis Substations on the Barre – Lewis 230 kV line.
- Upgrade the wave traps at Etiwanda Substation on the Vista 230 kV line.
- Upgrade the wave traps at Walnut Substation on the Mira Loma 230 kV line.
- Replacement of transmission line conductors on the San Bernardino – Vista 230 kV line.
    - Note: The San Bernardino – Vista 230 kV line conductors are overloaded over its N-2 rating.

The following items 1 – 4 also need to be evaluated for replacement or upgrade in the Facilities Study.

1. Breakers & Disconnects at Devers Substation on the Valley 500 kV line.
2. Breakers & Disconnects at Etiwanda Substation on the Vista 230 kV line.
3. Breakers at Mira Loma & Vista Substations on the Mira Loma - Vista 230 kV line.
4. Breakers & Disconnects at Walnut Substation on the Mira Loma 230 kV line.

Note:
Study results may change due to changes in other projects ahead of the queue in the area. A re-study may be required if there are changes in the project queue or the scope of projects ahead in the queue.

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THE AES CORPORATION

GENERATION INTERCONNECTION

SYSTEM IMPACT STUDY
TRANSMISSION ASSESSMENT

INTRODUCTION

The AES Corporation applied to the California Independent System Operator (CAISO) for Interconnection. The AES Corporation proposed to interconnect three gas turbine generators, each with a maximum operating rating at 108.19 MW. The generator auxiliary load is 1 MW and net capacity of the project is rated at 323.57 MW. The AES Corporation proposed to interconnect the project ("AES Highgrove Project") to the 115-kV bus at SCE's Highgrove Substation. The in-service date proposed by AES is January 1, 2007.

Southern California Edison's (SCE's) Transmission and Interconnection Planning (TIP) department has performed a System Impact Study to determine the adequacy of SCE's transmission system to accommodate the AES Highgrove Project. The study indicates that the system is not adequate to accommodate the 323.57 MW of generation without modifications. A Facilities Study will be required for the AES Highgrove Project.

The results of the System Impact Study will be used as the basis to determine project cost allocation for facility upgrades in the Facilities Study. ***The study accuracy and the results for the assessment of the system adequacy are contingent on the accuracy of the technical data provided by the AES Corporation.*** Any changes from the attached data could void the study results.

SCE's Field Engineering department has performed a System Impact Study on the SCE affected distribution network.

The study was performed for two system conditions: (a) 2007 heavy summer load conditions (once in-ten-year heat wave assumption) with maximum eastern area generation, and (b) 2007 spring load conditions (65% of 2007 heavy summer peak load) for the total transmission system. These conditions reflected the most critical expected loading condition for the transmission system in SCE's eastern area.

STUDY CONDITIONS AND ASSUMPTIONS

A. Planning Criteria

The study was conducted by applying the California Independent System Operator (CAISO) Reliability Criteria. More specifically, the main criteria applicable to this study are as follows:

Power Flow Assessment

The following contingencies are considered for transmission or sub-transmission lines and 500/230 kV transformer banks ("AA-Bank"):

Assuming both San Onofre Units 2 and 3 in service and then:

- Single Contingencies (N-1 Line or N-1 AA-Bank)
- Double Contingencies (N-2 Two Lines, N-1 Line and N-1 AA-Bank) (Outages of two AA-Banks are beyond the Planning Criteria)

The following criteria are used:

Transmission Lines	Base Case	Limiting Component Normal Rating
	N-1	Limiting Component A-Rating
	N-2	Limiting Component B-Rating
500-230 kV Transformer Banks	Base Case	Normal Loading Rating
	Long & Short Term	As Defined by SCE Operating Bulletins

Table 2.1

System upgrades or Special Protection Systems for transmission lines are generally recommended only for base case overloads, single contingency overloads in excess of the A-Rating, and common mode failure double contingencies in excess of the B-Rating.

Congestion Assessment

The following principles, outlined below, were used for interconnecting generation into the SCE transmission system, which fall under CAISO jurisdiction (these principles may be subject to change for future interconnection projects).

- Congestion management, as a means to mitigate base case overloads, can be used if it is determined to be manageable and the CAISO concurs with the implementation.

- Facility upgrades will be required if it is determined that the use of congestion management is unmanageable as defined in the congestion management section that follows.

- Special protection schemes (SPS), in lieu of facility upgrades, will be recommended if the scheme is effective, does not jeopardize system integrity, does not exceed the current CAISO single and double contingency tripping limitations, does not adversely effect existing or proposed special protection schemes in the area, and can be readily implemented.

- Facility upgrades will be required if use of protection schemes is determined to be ineffective, the amount of tripping exceeds the current CAISO single and double contingency tripping limitations, adverse impacts are identified on existing or currently proposed special protection schemes, or the scheme cannot be readily implemented.

- Congestion management in preparation for the next contingency will be required, with CAISO concurrence, if no facility upgrades or special protection schemes are implemented.

The following study method was implemented to assess the extent of possible congestion:

a) Under Base Case with all transmission facilities in service, the system was evaluated with all existing interconnected generation and all generation requests in the area that have a queue position ahead of this request (pre-project).

b) Under Base Case with all transmission facilities in service, the system was reevaluated with the inclusion of the AES Highgrove Project (post-project).

If the normal loading limits of facilities are exceeded in (a), the overload is identified as an existing overload that was triggered by a project in queue ahead of the AES Highgrove Project. If the normal loading limits of facilities are exceeded in (b) and were not exceeded in (a), the overload is identified as triggered by the addition of the AES Highgrove Project. The AES Highgrove Project, assuming it is a market participant, and other market participants in the area may be subjected to congestion management, potential upgrade cost and/or participation of any proposed special protection scheme if the project addition aggravates or triggers the overload. Additionally, the AES Highgrove Project may have to participate in mitigation of overloads triggered by subsequent projects in queue, subject to FERC protocols and policies.

In order for congestion management to be a feasible alternative to system facilities, all of the following factors need to be satisfied:

- Time requirements for necessary coordination and communication between the CAISO operators, scheduling operators and SCE operators.

- Distinct Path/Corridor rating should be well defined so monitoring and detecting congestion and implementing congestion of the contributing generation resources can be performed when limits are exceeded.

- Sufficient amount of market generation in either side of the congested path/corridor should be available to eliminate market power.

- Manageable generation in the affected area is necessary so that operators can implement congestion management if required (i.e. the dispatch schedule is known and controllable).

The results of these studies should identify:

a. if capacity is available to accommodate the proposed AES Highgrove Project and all projects ahead in queue without the need for congestion management, special protection schemes, or facility upgrades

b. if overloads exist in the area after the addition of all projects in queue ahead of the AES Highgrove Project and all facilities in service

c. if congestion exists in the area with the addition of the AES Highgrove Project and all projects ahead in queue under single and double element outage conditions assuming no new special protection schemes are in place

d. if sufficient capacity is maintained to accommodate all Must-Run and Regulatory Must-Take generation resources with all facilities in service

e. if sufficient capacity is maintained to accommodate the total output of any one generation resource which is not classified as Must-Run.

B. AES Highgrove Project

The AES Highgrove Generation Interconnection project is located at 12700 Taylor Street, Grand Terrace, CA – 92313; near Highgrove Substation. The Project is proposed to be connected radially to the Highgrove 115 kV bus. Appendix A displays the proposed AES Highgrove interconnection project in the form of a one line diagram, submitted by the AES Corporation as part of the CAISO Generation Interconnection Application package.

The AES Corporation proposes to add a net total of 323.57 MW of generation interconnected at the Highgrove 115kV bus. A total of three gas turbine generators will produce a rated output put of 108.19 MW each. The generator auxiliary load is specified at 1 MW. The generator and transformer data for the proposed generating turbines, as provided by the AES Corporation, is shown in Appendix C.

C. System Conditions

To simulate the SCE transmission system for analysis, the study selected the databases that were used to conduct the CAISO Controlled Transmission 2004-2008 Assessment. Load flow studies considered the existing system arrangement without the SDGE proposed Rainbow-Valley 500 kV transmission project and to reflect other transmission projects.

For example:

- Palo Verde – Devers 500 kV Line #2 was in service.
- All four West of Devers 230 kV Lines have been upgraded.
- The Etiwanda – San Bernardino 230 kV line #1 rating will be increased to 2480 Amps / 988 MVA after the current wave trap removal project is completed.

The bulk power study considered scenarios that evaluated maximum EOR/WOR imports and maximum generation from Qualified Facilities in the eastern area. These conditions were evaluated to identify worst case scenarios that would stress the SCE 500-kV transmission system network in the eastern area. In addition, the study considered two system load conditions: 2007 heavy summer and light spring. The summer peak load forecast was based on SCE's 2004 Transmission Substation Transformer Capacity Assessment, and reflects a one-in-ten-year heat wave assumption. The 2004 – 2008 heavy summer load forecast is shown in Table 2.2. The 2004 - 2008 spring forecast assumed 65% of summer load forecast.

D. Power Flow Study

Power flow studies were conducted under 2007 heavy summer and 2007 spring load conditions with and without the AES Highgrove Project for a total of 4 base cases. Further descriptions of the base case assumptions are as follows:

a) 2007 Heavy Summer: Case 1 **without** the AES Highgrove Project and Case 2 **with** maximum generation in SCE's eastern area electrical system and maximum EOR/WOR power flow. Generation included: all market and all regulatory must-take units. Generation patterns were maximized in the eastern area to fully stress the system in order to identify extent of potential congestion on the bulk power system with the addition of the AES Highgrove Project.

b) 2007 Spring: Case 3 **without** the AES Highgrove Project Case 4 **with** 2007 spring load (65% of summer peak for the total system) was used with maximum generation in SCE's eastern area and maximum EOR/WOR power flow. Generation included: all market and all regulatory must-take units. Generation patterns were maximized in the eastern area to fully stress the system in order to identify the extent of potential congestion on the bulk power system with the addition of the AES Highgrove Project.

With the addition of the AES Highgrove Project, SCE's area total generation, imports, loads, and losses for each case are summarized in table below:

SCE AREA TOTAL GENERATION, IMPORT, LOAD AND LOSSES (MW)				
	2007 Heavy Summer		2007 Light Spring	
	Case 1	Case 2	Case 3	Case 4
Generation	14983	14983	8160	8169
Imports	8313	8313	6613	6612
Load	22690	22690	14154	14154
Losses	507	512	519	529

Table 2.2

Simulations

For each of the four cases, load flow simulations of the bulk power system were conducted for the base case, single contingencies and double contingencies for lines and 500-230 kV transformer banks to determine impacts to the SCE system. A total of 177 single and 136 double contingencies in the SCE system were studied with system performance monitored for criteria violations on the SCE 500-kV and 230-kV systems.

E. Short Circuit Duty

The data provided by the AES Corporation has impacted 17 substations with increases in the short circuit duty. These impacts require further study to determine the need for circuit breaker upgrades.

POWER FLOW STUDY RESULTS

A. 2007 Spring Results

The power flow study identified base case, N-1 and N-2 overloads in the 2007 spring case. All percentages in the following results are expressed as percent loading of nominal value unless stated otherwise.

Base Case

There was one spring base case overloads triggered by projects ahead in queue. The addition of the AES Highgrove Project caused an insignificant overload. See Appendix B, Table 1 for detailed results.

The addition of the AES Highgrove Project caused the Devers – Valley 500 kV circuit to be overloaded from 113% to 114%; the difference being 1% is therefore deemed insignificant.

Light Spring Single Contingencies (N-1)

With the addition of the AES Highgrove Project, the power flow study identified seven transmission lines with N-1 overloads during spring conditions. See Appendix B, Table 2 for detailed results.

Two of these overloads (the Etiwanda-Vista 230-kV and Mira Loma-Walnut 230-kV lines) are limited by existing 2000 A wave traps at Vista and Walnut substations. Upgrade of both of these 2000A wave traps to 3000A will be sufficient to mitigate spring N-1 overloads on these lines. The conductor on the terminations at Barre & Lewis substations is the limiting factor on the Barre – Lewis 230 kV line. Upgrading these terminations from 3000A to 4000A will mitigate the N-1 overloads on the Barre – Lewis 230 kV line. The Mira Loma – Vista 230 kV line #1 is also overloaded due to the conductor and terminations at Vista substation. Upgrading these will mitigate the N-1 overloads.

The Devers – Valley 500 kV line is also overloaded to 117% of its nominal rating. The limiting factors are the wave traps at both Devers & Valley Substations and the GIS termination equipment at Valley substation. Upgrading the wave traps & GIS termination equipment from 3000A to 4000A will mitigate the N-1 overloads.

Light Spring Double Contingencies (N-2)

With the addition of the AES Highgrove Project, the power flow study identified five transmission lines with N-2 overloads during spring conditions. See Appendix B, Table 3 for detailed results.

Two of these overloads (the Devers-Valley 500-kV line and Serrano – Valley 500 kV line) will be mitigated by upgrades of the wave traps at both Devers & Valley Substations on the Devers-Valley 500-kV line. Also The GIS termination equipment at Valley substation is required to be upgraded from 3000A to 4000A on the Serrano and Devers positions.

The San Bernardino Vista 230 kV line is overloaded to 175% of its nominal rating. It will need to be re-conductored to mitigate the N-2 overloads.

The Etiwanda – Vista 230 kV line is limited by the wave trap & terminations at Etiwanda Substation. Upgrading these from 2000A to 3000A will mitigate the N-2 contingency overloads.

Also, the Mira Loma – Vista 230 kV line #1 is limited by the line drop at Vista substation. Upgrading the line drop from 2300A to 3000A will mitigate the N-2 overloads on this line.

B. 2007 Summer Results

Base Case

There were no significant changes to the base case with the addition of the AES Highgrove project.

Heavy Summer Single Contingencies (N-1)

With the addition of the AES Highgrove Project, the study identified only one transmission lines with N-1 contingency overloads during summer conditions. See Appendix B, Table 4 for detailed results.

The Devers – Valley 500 kV line is overloaded to 102% of its nominal rating. The limiting factors are the wave traps at both Devers & Valley Substations and the GIS termination equipment at Valley substation. Upgrading the wave traps & GIS termination equipment from 3000A to 4000A will mitigate the N-1 and N-2 overloads. See the Spring Results section above for details

Heavy Summer Double Contingencies (N-2)

With the addition of the AES Highgrove Project, the study identified only one transmission lines with N-2 contingency overloads during summer conditions. See Appendix B, Table 5 for detailed results.

The Devers – Valley 500 kV line is overloaded to 108% of its nominal rating. The limiting factors are the wave traps at both Devers & Valley Substations and the GIS termination equipment at Valley substation. Upgrading the wave traps & GIS termination equipment from 3000A to 4000A will mitigate the N-1 and N-2 overloads. See the Spring Results section above for details

Note:

Additional overloads were identified on the disconnect switches and circuit breakers. However, these overloads will be addressed through Edison's internal Substation Equipment Replacement Program (SERP)

TRANSIENT AND POST TRANSIENT VOLTAGE STUDY RESULTS

There were no transient stability and post-transient voltage violations found with the addition of the AES Highgrove Project.

SHORT CURCUIT DUTY STUDY RESULTS

Short Circuit Duty Study

The results of the maximum symmetrical three-phase short circuit duty at the critical buses in the SCE bulk transmission system are summarized in table 3.6 (the short circuit duty sheet).

The additional 323.57 MW AES Highgrove Project has increased the short circuit duty at the substation facilities listed below for future review. However, study results may change due to other projects ahead of the queue in the area. A new study may be required when those projects are revised.

Three Phase (3PH) Short Circuit Duty Study Results

Short Circuit Duty Sheet

Bus Name	Bus KV	PRE CASE		POST CASE		OVERLOAD
		X/R	KA	X/R	KA	KA
DEVERS	500	16.5	24	16.6	24.1	0.1
LUGO	500	21.7	43.9	21.7	44.1	0.2
MIRALOMA	500	24.4	33.4	24.6	33.6	0.2
SERRANO	500	24.3	29.9	24.3	30	0.1
BARRE	230	18.7	49.3	18.7	49.4	0.1
CHINO	230	17.1	47.9	17	48.2	0.3
DELAMO	230	16	41.1	16	41.2	0.1
DEVERS	230	21.2	44.9	21.1	45.1	0.2
ETIWANDA	230	25.8	57.1	25.9	57.7	0.6
HUNTBCHB	230	14.8	30.1	14.7	30.2	0.1
LA FRESA	230	26.5	46.3	26.5	46.4	0.1
LUGO	230	30.8	36.7	30.9	36.8	0.1
MRLOMA E	230	23.2	59.4	23.2	60	0.6
MRLOMA W	230	20.3	50.2	20.3	50.6	0.4
OLINDA	230	13.9	27.1	13.9	27.2	0.1
PADUA	230	15.3	20.6	15.3	20.7	0.1
S.ONOFRE	230	26.2	48.8	26.2	48.9	0.1
SANBRDNO	230	21	39.6	21	40.1	0.5
SERRANO	230	24.4	52.7	24.4	52.9	0.2
VILLA PK	230	21.8	46.2	21.9	46.3	0.1
VISTA	230	19.1	48	19.9	50	2
ALTWIND	115	10.6	12.9	10.6	13	0.1

Table 3.6

Notes:

- **No Equivalencing was made of the Vista Sub-transmission system.**

CONCLUSIONS

A. Power Flow Study Conclusions

Load flow studies were conducted under 2007 heavy summer and 2007 light spring load conditions with and without the AES Highgrove Project for a total of 4 cases.

Palo Verde – Devers 500 kV Line #2 was assumed to be in service and all four West of Devers 230 kV Lines were assumed had been upgraded.

Base case

No base case overload problems were found under the light spring and heavy summer conditions with the addition of the AES Highgrove Project.

N-1

Under spring conditions, the project overloaded the Devers – Valley 500 kV line to 117% and the Etiwanda – Vista 230 kV line to 107%. The Etiwanda – San Bernardino 230 kV, Mira Loma – Walnut 230 kV and Mira Loma – Vista 230 kV lines were overloaded to 140%, 110% and 124% respectively. Also, the Barre – Lewis 230 kV line was overloaded to 124%. Under summer conditions the Devers – Valley 500 kV line was overloaded to 104%.

N-2

Under spring conditions, the project overloaded the Devers – Valley and Serrano – Valley 500 kV lines to 129% and 101% respectively. The Etiwanda – Vista, Mira Loma – Vista and San Bernardino – Vista 230 kV lines were overloaded to 150%, 137% and 175% respectively. Under heavy summer conditions, the Devers – Valley 500 kV line was overloaded to 108%.

B. Transient Stability and Post Transient Voltage Study Conclusions

There were no transient stability and post-transient voltage violations found with the addition of the AES Highgrove Project.

C. Short Circuit Duty Study Conclusions

The additional 323.57 MW AES Highgrove Project has increased the short circuit duty at the substation facilities listed below for further review. However, study results may change due to other projects ahead of the queue in the area. A new study may be required when those projects are revised.

Affected Substations:

A total of 17 substations have been affected with increases in short circuit duty. Refer to table 3.6 – Short Circuit Duty Sheet for details.

The Lines & elements overloaded from contingencies and MW required to be tripped / curtailed are listed below.

Table 4

Single Contingencies

Out of Service Transmission Element	Overloaded Transmission Element	Maximum MW Generation to be tripped or manually curtailed
Mira Loma -Vista 230 kV ck2	Etiwanda-Vista 230 kV ck1	108.19 MW
Mira Loma -Olinda 230 kV ck2	Mira Loma – Walnut 230 kV ck1	323.57 MW
Etiwanda – San Bernardino 230 kV ck1	Etiwanda-Vista 230 kV ck1	108.19 MW
Mira Loma -Vista 230 kV ck1	Etiwanda-Vista 230 kV ck1	108.19 MW
	Devers-Valley 500 kV ck1	323.57 MW
Barre – Villa Park 230 kV ck1	Barre – Lewis 230 kV ck1	323.57 MW
Mira Loma – Serrano 500 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
Serrano – Valley 500 kV ck1	Etiwanda-San Bernardino 230 kV ck1	323.57 MW
	Mira Loma – Vista 230 kV ck1	323.57 MW
	Etiwanda-Vista 230 kV ck1	108.19 MW
Devers – Valley 500 kV ck1	Etiwanda-San Bernardino 230 kV ck1	323.57 MW
	Mira Loma – Vista 230 kV ck1	323.57 MW
	Etiwanda-Vista 230 kV ck1	108.19 MW

Table 4 contd.

Double Contingencies

Out of Service Transmission Element	Overloaded Transmission Element	MW Generation to be tripped or manually curtailed
Chino - Serrano 230 kV ck1 & Mira Loma - Olinda 230 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck1	Etiwanda - Vista 230 kV ck1	323.57 MW
	Devers-Valley 500 kV ck1	323.57 MW
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck2	Etiwanda - Vista 230 kV ck1	323.57 MW
	Devers-Valley 500 kV ck1	323.57 MW
	Mira Loma - Vista 230 kV ck1	323.57 MW
Etiwanda - San Bernardino 230 kV ck1 & Etiwanda – Vista 230 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
	Mira Loma - Vista 230 kV ck1	323.57 MW
Devers - San Bernardino 230 kV ck2 & Etiwanda - San Bernardino 230 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
Devers – Vista 230 kV ck2 & Vista – Devers 230 kv ck1	San Bernardino – Vista 230 kV ck2	323.57 MW
	Serrano – Valley 500 kV ck1	108.19 MW
	Devers-Valley 500 kV ck1	323.57 MW
Etiwanda – San Bernardino 230 kV ck1 & Lugo – Serrano 500 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
Etiwanda – San Bernardino 230 kV ck1 & Lugo – Mira Loma 500 kV ck1	Devers-Valley 500 kV ck1	323.57 MW
Devers-Valley 500 kV ck1 Devers 500 / 230 kV Bank #1	Etiwanda-Vista 230 kV ck1	108.19 MW
Mira Loma - Vista 230 kV ck1 & Mira Loma - Vista 230 kV ck2	Devers-Valley 500 kV ck1	323.57 MW

SCOPE OF WORK FOR FACILITIES STUDY

The scope of upgrades to accommodate the generation interconnection on the SCE network is listed below. This study has not assumed overload mitigation requirements for projects ahead of the queue.

- Upgrades of the 3000A wave traps and line terminals at Valley Substation 4000A on the Devers – Valley 500 kV line.
- Upgrades of line terminals at Serrano & Valley substations on the Serrano - Valley 500 kV line.
- Upgrades of line terminals at Vista and San Bernardino substations on the Vista – San Bernardino 230 kV line from 2300A to 3000A (or greater) line terminals.
- Upgrades of line terminals at Vista Substation on the Etiwanda and Mira Loma #1 230 kV lines
- Upgrade of line terminals at Barre & Lewis Substations on the Barre – Lewis 230 kV line.
- Upgrade the wave traps at Etiwanda Substation on the Vista 230 kV line.
- Upgrade the wave traps at Walnut Substation on the Mira Loma 230 kV line.
- Replacement of transmission line conductors on the San Bernardino – Vista 230 kV line.
    - Note: The San Bernardino – Vista 230 kV line conductors are overloaded over its N-2 rating.

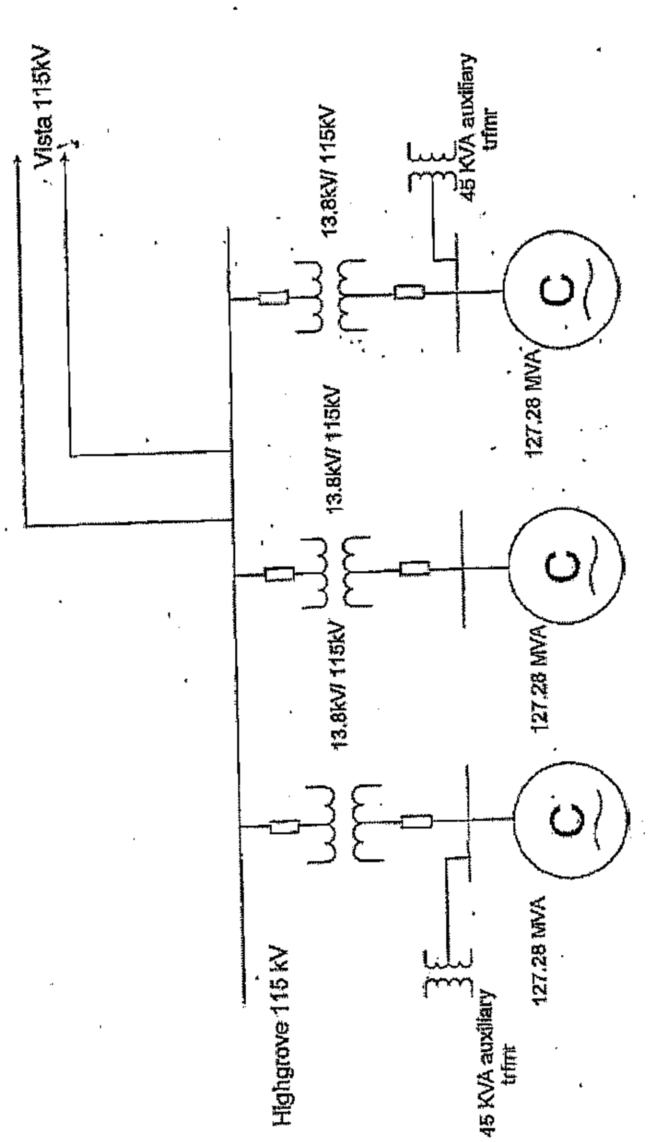
The following items 1 – 4 also need to be evaluated for replacement or upgrade in the Facilities Study.

1. Breakers & Disconnects at Devers Substation on the Valley 500 kV line.
2. Breakers & Disconnects at Etiwanda Substation on the Vista 230 kV line.
3. Breakers at Mira Loma & Vista Substations on the Mira Loma - Vista 230 kV line.
4. Breakers & Disconnects at Walnut Substation on the Mira Loma 230 kV line.

Note:
Study results may change due to other projects ahead of the queue in the area. A new study may be required if projects ahead of the queue are changed.

APPENDIX A

SINGLE LINE DIAGRAM



APPENDIX B
POWER FLOW RESULTS

TABLE 1
Base Case Overloads – Spring Conditions

Overloaded Transmission Element	Rated Capacity Amps	Pre-Project Amps (%)	Post-Project Amps (%)	Impact Amps (%)
Devers – Valley 500kV ck 1	3000	3381 (113%)	3414 (114%)	33 (1%)

TABLE 2
Single Contingency Overloads – Spring Condition

Out of Service Transmission Element	Overloaded Transmission Element	Rated Capacity Amps	Pre-Project Amps (%)	Post-Project Amps (%)	Impact Amps (%)
Mira Loma -Vista 230 kV ck2	Etiwanda-Vista 230 kV ck1	2000	1790 (90%)	2056 (103%)	266 (13%)
	Devers-Valley 500 kV ck1	3000	3438 (115%)	3480 (116%)	42 (1%)
Mira Loma -Olinda 230 kV ck2	Mira Loma – Walnut 230 kV ck1	2000	2083 (104%)	2206 (110%)	123 (6%)
Etiwanda – San Bernardino 230 kV ck1	Etiwanda-Vista 230 kV ck1	2000	1889 (94%)	2110 (106%)	221 (12%)
Mira Loma -Vista 230 kV ck1	Etiwanda-Vista 230 kV ck1	2000	1855 (93%)	2119 (106%)	264 (13%)
	Devers-Valley 500 kV ck1	3000	3468 (116%)	3514 (117%)	46 (1%)
Barre – Villa Park 230 kV ck1	Barre – Lewis 230 kV ck1	3000	3314 (110%)	3706 (124%)	392 (11%)
Serrano – Valley 500 kV ck1	Etiwanda-San Bernardino 230 kV ck1	1800	2421 (135%)	2511 (140%)	90 (5%)
	Mira Loma – Vista 230 kV ck1	2300	2618 (114%)	2852 (124%)	234 (9%)
	Etiwanda-Vista 230 kV ck1	2000	1933 (97%)	2135 (107%)	202 (10%)
Devers – Valley 500 kV ck1	Etiwanda-San Bernardino 230 kV ck1	1800	2421 (135%)	2511 (140%)	90 (5%)
	Mira Loma – Vista 230 kV ck1	2300	2618 (114%)	2852 (124%)	234 (9%)
	Etiwanda-Vista 230 kV ck1	2000	1933 (97%)	2135 (107%)	202 (10%)

TABLE 3

Double Contingency Overloads – Spring Condition

Out of Service Transmission Element(s)	Overloaded Transmission Element	Rated Capacity Amps	Pre-Project Amps (%)	Post-Project (Amps)	Impact Amps (%)
Chino – Serrano 230 kV ck1 & Mira Loma - Olinda 230 kV ck1	Devers-Valley 500 kV ck1	3000	3153 (105%)	3447 (115%)	294 (10%)
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck1	Etiwanda - Vista 230 kV ck1	2000	2696 (135%)	3010 (150%)	314 (15%)
	Devers-Valley 500 kV ck1	3000	3610 (120%)	3665 (122%)	55 (2%)
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck2	Etiwanda - Vista 230 kV ck1	2000	2694 (135%)	3011 (150%)	317 (15%)
	Devers-Valley 500 kV ck1	3000	3580 (119%)	3630 (121%)	50 (2%)
	Mira Loma - Vista 230 kV ck1	2300	2861 (124%)	3176 (138%)	315 (14%)
Etiwanda - San Bernardino 230 kV ck1 & Etiwanda – Vista 230 kV ck1	Devers-Valley 500 kV ck1	3000	3588 (120%)	3638 (121%)	50 (2%)
	Mira Loma - Vista 230 kV ck1	2300	2837 (123%)	3149 (137%)	312 (14%)
Devers - San Bernardino 230 kV ck2 & Etiwanda - San Bernardino 230 kV ck1	Devers-Valley 500 kV ck1	3000	3575 (119%)	3638 (121%)	63 (2%)
Devers – Vista 230 kV ck2 & Vista – Devers 230 kv ck1	San Bernardino – Vista 230 kV ck2	2300	3749 (163%)	4020 (175%)	541 (12%)
	Serrano – Valley 500 kV ck1	3000	2685 (90%)	3017 (101%)	332 (11%)
	Devers-Valley 500 kV ck1	3000	3519 (117%)	3870 (129%)	351 (12%)
Etiwanda – San Bernardino 230 kV ck1 & Lugo – Serrano 500 kV ck1	Devers-Valley 500 kV ck1	3000	3483 (116%)	3523 (118%)	40 (2%)
Devers-Valley 500 kV ck1 Devers 500 / 230 kV Bank #1	Etiwanda-Vista 230 kV ck1	2000	1921 (96%)	2201 (110%)	280 (14%)

TABLE 4

Single Contingency Overloads – Summer Condition

Out of Service Transmission Element	Overloaded Transmission Element	Rated Capacity Amps	Pre-Project Amps (%)	Post-Project Amps (%)	Impact Amps (%)
Mira Loma -Vista 230 kV ck1	Devers – Valley 500 kV ck1	3000	3066 (102%)	3117 (104%)	51 (2%)
Mira Loma -Vista 230 kV ck2	Devers – Valley 500 kV ck1	3000	3033 (102%)	3078 (104%)	45 (2%)
Mira Loma –Serrano 500 kV ck1	Devers – Valley 500 kV ck1	3000	3036 (101%)	3081 (103%)	45 (2%)
Etiwanda – Mira Loma 230 kV ck1	Devers – Valley 500 kV ck1	3000	3021 (100%)	3066 (102%)	45 (2%)

TABLE 5

Double Contingency Overloads – Summer Condition

Out of Service Transmission Element(s)	Overloaded Transmission Element	Rated Capacity Amps	Pre-Project Amps (%)	Post-Project (Amps)	Impact Amps (%)
Mira Loma - Vista 230 kV ck1 & Mira Loma - Vista 230 kV ck2	Devers-Valley 500 kV ck1	3000	3165 (106%)	3237 (108%)	72 (2%)
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck1	Devers-Valley 500 kV ck1	3000	3144 (105%)	3198 (107%)	54 (2%)
Etiwanda – San Bernardino 230 kV ck1 & Mira Loma - Vista 230 kV ck2	Devers-Valley 500 kV ck1	3000	3111 (104%)	3162 (106%)	51 (2%)
Etiwanda - San Bernardino 230 kV ck1 & Etiwanda – Vista 230 kV ck1	Devers-Valley 500 kV ck1	3000	3105 (103%)	3153 (105%)	48 (2%)
Etiwanda – San Bernardino 230 kV ck1 & Lugo - Mira Loma 230 kV ck3	Devers-Valley 500 kV ck1	3000	3087 (103%)	3123 (105%)	48 (2%)

APPENDIX C
GOOD FAITH COST ESTIMATE

All items include 18% A&G but no ITCC Tax.

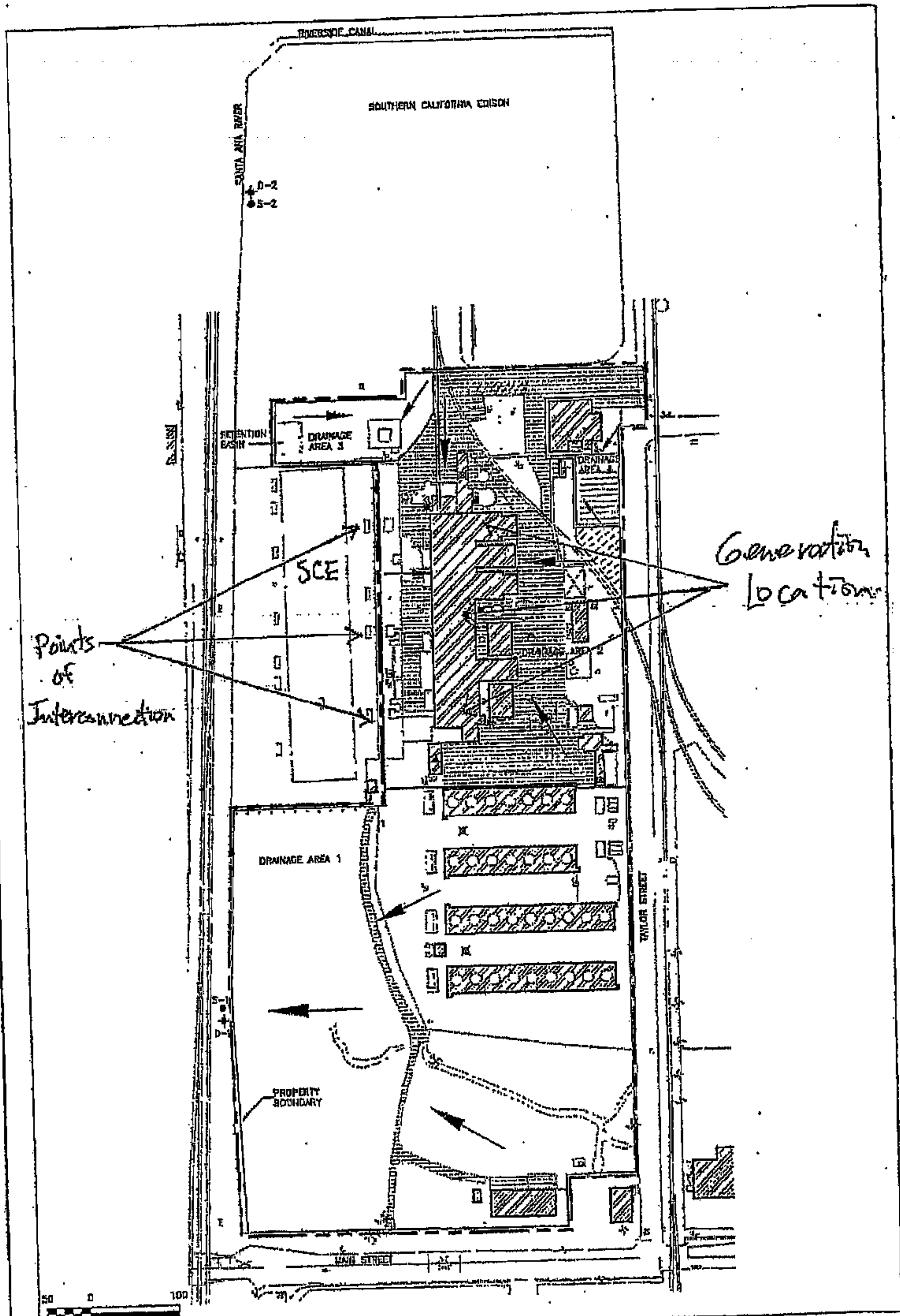
1) Upgrade of wave trap at Valley Substation on the Devers 500 kV line.
   Replacement of 500 kV Wave Trap: $90,000
2) Upgrade of line drops at Vista & San Bernardino substations.
   Replacement of 230 kV line drops: $120,000 ($60,000 each).
3) Upgrade of line drops at Barre & Lewis substations.
   Replacement of 230 kV line drops: $120,000 ($60,000 each).
4) Upgrade of wave trap at Etiwanda Substation on the Vista 230 kV line.
   Replacement of 230 kV Wave Trap: $80,000
5) Upgrade of wave trap at Walnut Substation on the Mira Loma 230 kV line.
   Replacement of 230 kV Wave Trap: $80,000

TOTAL : $490,000

Note:
Per the transmission assessment of the AES Highgrove study, it is not possible to estimate the GIS equipment upgrades and line reconductoring at this time. However, the GIS equipment upgrades will be addressed in the facilities study.

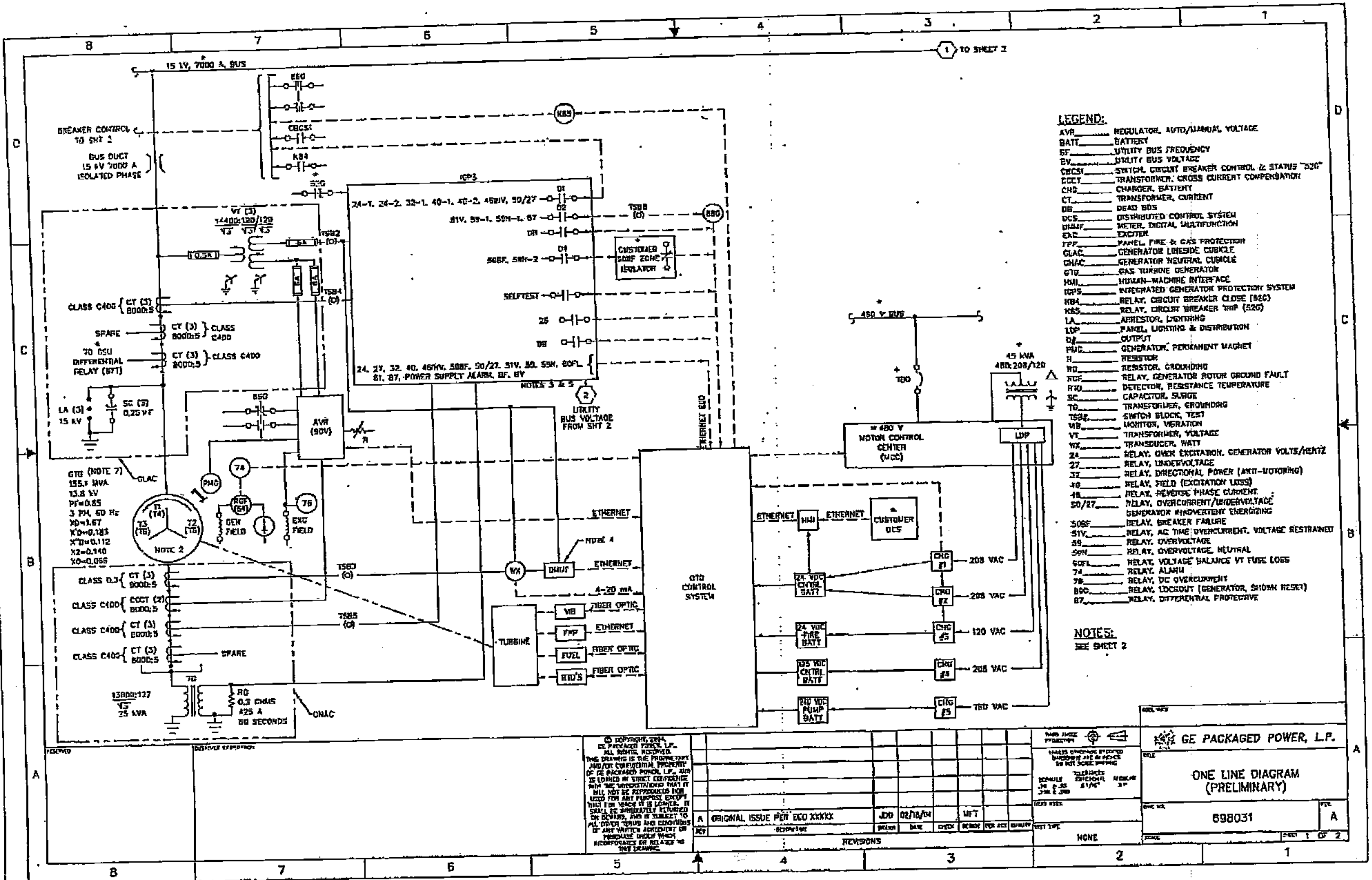
APPENDIX D

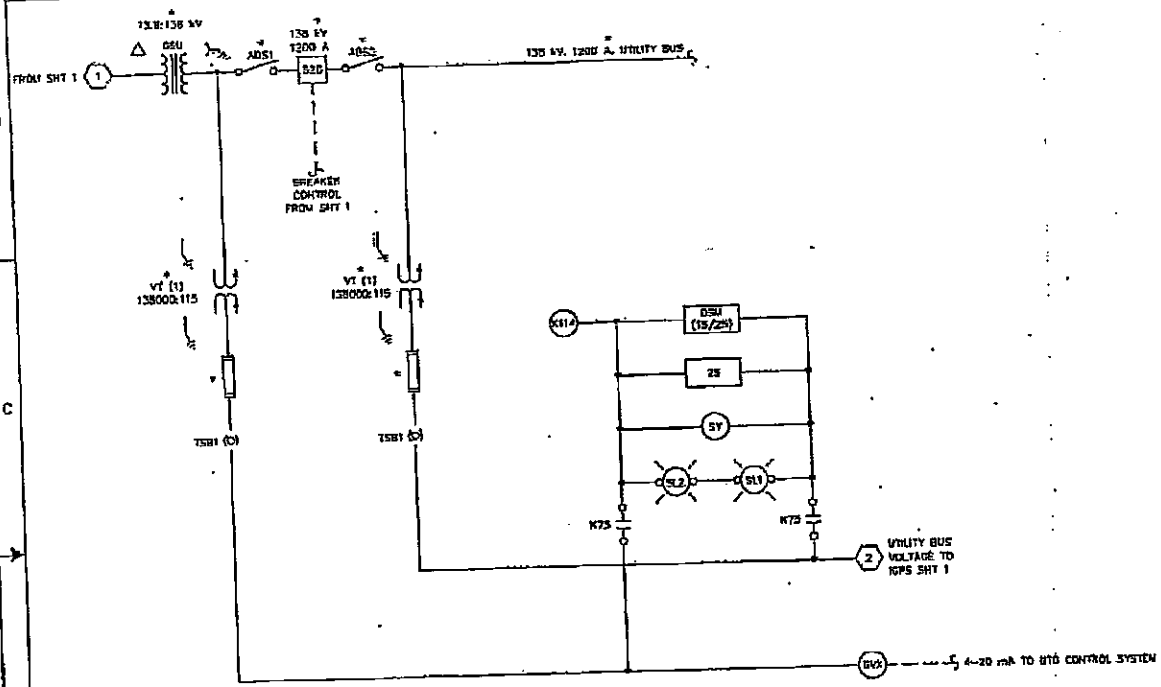
File: F:\Riverside Canal\15201\SWPPP\Riverside Canal map\...dwg Layout: ANSI_BW-CP User: ... Plotted: Aug 08, 2002 - 3:37pm Xref's:



RETEC

RIVERSIDE CANAL POWER COMPANY STORMWATER POLLUTION PREVENTION PLAN	FACILITY MAP
DATE 08/08/02 DRWN: F.C./L.D.	FIGURE 2


LEGEND:
AVR — REGULATOR, AUTO/MANUAL VOLTAGE
BATT — BATTERY
BF — UTILITY BUS FREQUENCY
BV — UTILITY BUS VOLTAGE
CBCS — SWITCH, CIRCUIT BREAKER CONTROL & STATUS "52G"
CCCT — TRANSFORMER, CROSS CURRENT COMPENSATION
CHG — CHARGER, BATTERY
CT — TRANSFORMER, CURRENT
DB — DEAD BUS
DCS — DISTRIBUTED CONTROL SYSTEM
DMMF — METER, DIGITAL MULTIFUNCTION
EXC — EXCITER
FPP — PANEL, FIRE & GAS PROTECTION
GLAC — GENERATOR LINESIDE CUBICLE
GNAC — GENERATOR NEUTRAL CUBICLE
GTG — GAS TURBINE GENERATOR
HMI — HUMAN-MACHINE INTERFACE
IGPS — INTEGRATED GENERATOR PROTECTION SYSTEM
K84 — RELAY, CIRCUIT BREAKER CLOSE (52G)
K85 — RELAY, CIRCUIT BREAKER TRIP (52G)
LA — ARRESTOR, LIGHTNING
LDP — PANEL, LIGHTING & DISTRIBUTION
D — OUTPUT
PMG — GENERATOR, PERMANENT MAGNET
R — RESISTOR
RG — RESISTOR, GROUNDING
RGF — RELAY, GENERATOR ROTOR GROUND FAULT
RTD — DETECTOR, RESISTANCE TEMPERATURE
SC — CAPACITOR, SURGE
TG — TRANSFORMER, GROUNDING
TSB — SWITCH BLOCK, TEST
VIB — MONITOR, VIBRATION
VT — TRANSFORMER, VOLTAGE
WX — TRANSDUCER, WATT
24 — RELAY, OVER EXCITATION, GENERATOR VOLTS/HERTZ
27 — RELAY, UNDERVOLTAGE
32 — RELAY, DIRECTIONAL POWER (ANTI-MOTORING)
40 — RELAY, FIELD (EXCITATION LOSS)
46 — RELAY, REVERSE PHASE CURRENT
50/27 — RELAY, OVERCURRENT/UNDERVOLTAGE GENERATOR INADVERTENT ENERGIZING
50BF — RELAY, BREAKER FAILURE
51V — RELAY, AC TIME OVERCURRENT, VOLTAGE RESTRAINED
59 — RELAY, OVERVOLTAGE
59N — RELAY, OVERVOLTAGE, NEUTRAL
60FL — RELAY, VOLTAGE BALANCE VT FUSE LOSS
74 — RELAY, ALARM
76 — RELAY, DC OVERCURRENT
86G — RELAY, LOCKOUT (GENERATOR, SHOWN RESET)
87 — RELAY, DIFFERENTIAL PROTECTIVE
NOTES:
SEE SHEET 2
15 kV, 7000 A, BUS
1 TO SHEET 2
BREAKER CONTROL TO SHT 2
BUS DUCT 15 kV 7000 A ISOLATED PHASE
86G
CBCS
K84
K85
52G
IGPS
24-T, 24-2, 32-1, 40-1, 40-2, 46INV, 50/27
51V, 59-1, 59N-1, 87
DB
50BF, 59N-2
SELFTEST
25
BF
24, 27, 32, 40, 46INV, 50BF, 50/27, 51V, 59, 59N, 60FL, 81, 87, POWER SUPPLY ALARM, BF, BV
NOTES 3 & 5
2 UTILITY BUS VOLTAGE FROM SHT 2
TSB8 (O)
CUSTOMER SWF ZONE ISOLATOR
VT (3) 14400:120/120
TSB2 (O)
TSB4 (O)
CLASS C400 CT (3) 8000:5
SPARE CT (3) 8000:5 CLASS C400
TO DSU DIFFERENTIAL RELAY (87T) CT (3) 8000:5 CLASS C400
LA (3) 15 kV
SC (3) 0.25 µF
AVR (90V)
R
GLAC
GTG (NOTE 7) 155.4 MVA 13.8 kV PF=0.85 3 PH, 60 Hz Xd=1.67 X'd=0.183 X"d=0.112 X2=0.140 X0=0.055
PMG
74
RGF (64)
GEN FIELD
76
EXC FIELD
NOTE 2
CLASS 0.3 CT (3) 8000:5
CLASS C400 CCCT (2) 8000:5
CLASS C400 CT (3) 8000:5
CLASS C400 CT (3) 8000:5 SPARE
TG 13800:127 25 kVA
RG 0.3 OHMS 425 A 60 SECONDS
GNAC
TSB3 (O)
TSB5 (O)
WX
DMMF
NOTE 4
ETHERNET
4-20 mA
TURBINE
VIB FIBER OPTIC
FPP ETHERNET
FUEL FIBER OPTIC
RTD'S FIBER OPTIC
ETHERNET EGD
GTG CONTROL SYSTEM
HMI
CUSTOMER DCS
24 VDC CNTRL BATT
24 VDC FIRE BATT
125 VDC CNTRL BATT
240 VDC PUMP BATT
CHG #1 208 VAC
CHG #2 208 VAC
CHG #3 120 VAC
CHG #4 208 VAC
CHG #5 480 VAC
480 V BUS
T00
480 V MOTOR CONTROL CENTER (MCC)
LDP
45 kVA 480:208/120
GE PACKAGED POWER, L.P.
ONE LINE DIAGRAM (PRELIMINARY)
698031
A
SHEET 1 OF 2
NONE
A ORIGINAL ISSUE PER ECO XXXXX JDD 02/18/04 MFT
REVISIONS



LEGEND:

ADS#____ SWITCH, AIR DISCONNECT
DSM____ SYNCHRONIZER, AUTO SPEED-VOLTAGE MATCHING
GSU____ GENERATOR STEP-UP TRANSFORMER
GVX____ TRANSDUCER, GENERATOR VOLTAGE
K75____ RELAY, GTG/BUS SYNCHRONIZER ENABLE
X11#____ RELAY, DSM GENERATOR SENSE ENABLE
SL#____ LAMP, SYNCHRONIZING
SY____ METER, SYNCHROSCOPE
TSB#____ SWITCH BLOCK, TEST
VT____ TRANSFORMER, VOLTAGE
25____ RELAY, SYNC CHECK
52G____ AC CIRCUIT BREAKER (GENERATOR)

NOTES:

1. * ASTERISK INDICATES FURNISHED BY OTHERS. ITEMS SHOWN AS "BY OTHERS" MAY VARY BUT ARE SHOWN TO ATTEMPT CLARITY OF PERSPECTIVE ON THIS DRAWING
2. GENERATOR PHASE SEQUENCE IS T1-T2-T3 FOR LEFT HAND LINESIDE CUBICLE OR T4-T5-T6 FOR RIGHT HAND LINESIDE CUBICLE. SEE MAIN UNIT GENERAL ARRANGEMENT FOR LINESIDE PLACEMENT.
3. VOLTAGE TRANSFORMER FUSE LOSS DETECTION HAS BEEN PROGRAMMED IN THE IGPS.
4. DMMF INCLUDES THE FOLLOWING: VOLTS, AMPS, POWER FACTOR, KW, KVA, KVAR, FREQ., KVAH & KWH
5. REFERENCE X-Y-698060 FOR RELAY SETTINGS.
6. CUSTOMER DRAWING NUMBERS CONSIST OF: (ORDER NUMBER)-(CONFIG. OR SITE)-(STANDARD DRAWING NUMBER), AND REFERENCED AS X-Y-(STANDARD DRAWING NUMBER). WHERE X=ORDER NUMBER AND Y=CONFIG. OR SITE.
7. GENERATOR RATING AT 59 °F (15 °C) AMBIENT AND 0 ft (0 m) ELEVATION.

REVISIONS

REV	DESCRIPTION	DRAWN	DATE	CHECK	DESIGN	ENG APP	DRAFT
A	ORIGINAL ISSUE PER ECO XXXXX	JDD	02/18/94		MFT		

GE PACKAGED POWER, L.P.

ONE LINE DIAGRAM (PRELIMINARY)

DWG NO. 698031

UNIT TYPE LM6000

SCALE NONE

SHEET 2 OF 2

BRUSH ELECTRICAL MACHINES LTD

BRUSH
— BRUSH BEM Ltd. —

ELECTRICAL DATA SHEET

P O Box 18, Falcon Works, Loughborough, Leics. LE11 1HJ, England
Telephone: +44 (0) 1509 611511 Telefax: +44 (0) 1509 612345 E-mail: Sales@bem.fki-et.com

1. RATING DETAILS

1.1	Frame size	BDAX 98-330ER
1.2	Terminal voltage	13.80 kV
1.3	Frequency	60 Hz
1.4	Speed	3600 rev/min
1.5	Power factor	0.850
1.6	Rated stator line current	5325 Amps
1.7	Applicable national standard	ANSI C50.14
1.8	Rated air inlet temperature	15.0 °C
1.9	Rated output with air flow of 28.7 m^3/sec	108.190 MW, 127.282 MVA

2. PERFORMANCE CURVES (revision in accordance with test)

2.1	Output vs. air inlet temperature with air flow of 28.7 m^3/sec	H.E.P. 19906
2.2	Capability diagram with air flow of 28.7 m^3/sec	H.E.P. 19907
2.3	Efficiency vs. output with air flow of 28.7 m^3/sec	H.E.P. 19908
2.4	Open and Short circuit curves	H.E.P. 19951
2.5	Permitted duration of negative sequence current	H.E.P. 2959
2.6	Decrement curve for a 3 phase short circuit from full load	H.E.P. 19871
2.7	Generator Voltage/frequency capability	H.E.P. 4727
2.8	Generator V-Curves	H.E.P. 20379
2.9	Exciter Open and Load characteristic (high exciter field resistance selection)	H.E.P. 20378
2.10	Exciter Open and Load characteristic (low exciter field resistance selection)	H.E.P. N/A
2.11	Stator winding earth fault current versus time	H.E.P. 20375
2.12	Permissible Short time stator current overload of generator	H.E.P. 5987
2.13	Estimated PMG regulation characteristic (high voltage PMG selection)	H.E.P. 20412
2.14	Estimated PMG regulation characteristic	

The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

(low voltage PMG selection) H.E.P. 20411

BRUSH ELECTRICAL MACHINES LTD

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

3. REACTANCE AND SEQUENCE RESISTANCES

A) Direct Axis Reactances: (revision in accordance with test)

3.1	Saturated synchronous reactance, $X_{d(v)}$ / Short circuit ratio	155.5 % / 0.643
3.2	Unsaturated synchronous reactance, $X_{d(i)}$	165.2 %
3.3	Saturated transient reactance, $X'_{d(v)}$	18.55 % ±15 %
3.4	Unsaturated transient reactance, $X'_{d(i)}$	21.19 %
3.5	Saturated sub transient reactance, $X''_{d(v)}$	12.08 % ± 15 %
3.6	Unsaturated sub transient reactance, $X''_{d(i)}$	15.82 %
3.7	Saturated negative sequence reactance, $X_{2(v)}$	13.2 %
3.8	Unsaturated negative sequence reactance, $X_{2(i)}$	15.48 %
3.9	Saturated zero sequence reactance, $X_{0(v)}$	7.85 %
3.10	Unsaturated zero sequence reactance, $X_{0(i)}$	7.85 %
3.11	Potier reactance, X_P	21.38 %
3.12	Saturated stator leakage, $X_{sl(v)}$	9.53 %
3.13	Unsaturated stator leakage, $X_{sl(i)}$	11.21 %

B) Quadrature Axis Reactances:

3.14	Saturated synchronous reactance, $X_{q(v)}$	134.6 %
3.15	Unsaturated synchronous reactance, $X_{q(i)}$	159 %
3.16	Saturated transient reactance, $X'_{q(v)}$	24.8 %
3.17	Unsaturated transient reactance, $X'_{q(i)}$	29.2 %
3.18	Saturated sub transient reactance, $X''_{q(v)}$	11.5 %
3.19	Unsaturated sub transient reactance, $X''_{q(i)}$	13.5 %

C) Sequence resistances: (revision in accordance with test)

3.20	Positive sequence resistance, R_1	0.00259 p.u at 75 °C
3.21	Negative sequence resistance, R_2	0.00978 p.u at 75 °C
3.22	Zero sequence resistance, R_0	0.00100 p.u at 75 °C

4. RESISTANCES (revision in accordance with test)

4.1	Rotor resistance	0.2225 Ohms at 20 °C

The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

4.2	Rotor resistance	0.2923 Ohms at 100 °C
4.3	Stator resistance per phase	0.00085 Ohms at 20 °C
4.4	Stator resistance per phase	0.00111 Ohms at 100 °C

5. TIME CONSTANTS AT 20°C

A) **Direct Axis:** (revision in accordance with test)

5.1	Transient O.C. time constant, T'_{do}	10.6 seconds
5.2	Transient S.C. time constant, 3 ph, T'_{d3}	0.93 seconds
5.3	Transient S.C. time constant, L-L, T'_{d2}	2.1 seconds
5.4	Transient S.C. time constant, L-N, T'_{d1}	2.5 seconds
5.5	Subtransient O.C. time constant, T''_{do}	0.04 seconds
5.6	Subtransient S.C. time constant, 3 ph, T''_{d3}	0.03 seconds
5.7	Subtransient S.C. time constant, L-L, T''_{d2}	0.037 seconds
5.8	Subtransient S.C. time constant, L-N, T''_{d1}	0.038 seconds

B) **Quadrature Axis:**

5.9	Transient O.C. time constant, T'_{qo}	3.8 seconds
5.10	Transient S.C. time constant, 3 ph, T'_{q3}	0.7 seconds
5.11	Transient S.C. time constant, L-L, T'_{q2}	0.95 seconds
5.12	Transient S.C. time constant, L-N, T'_{q1}	1.05 seconds
5.13	Subtransient O.C. time constant, T''_{qo}	0.042 seconds
5.14	Subtransient S.C. time constant, 3 ph, T''_{q3}	0.019 seconds
5.15	Subtransient S.C. time constant, L-L, T''_{q2}	0.027 seconds
5.16	Subtransient S.C. time constant, L-N, T''_{q1}	0.029 seconds

C) **Miscellaneous:** (revision in accordance with test)

5.17	D.C. Armature time constant, 3 ph, T_{a3}	0.74 seconds
5.18	D.C. Armature time constant, L-L, T_{a2}	0.74 seconds
5.19	D.C. Armature time constant, L-N, T_{a1}	0.51 seconds

6. INERTIA (revision in accordance with test)

6.1	Moment of inertia, WR^2 (See note 2)	3813 kg.m^2

The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

6.2.	Inertia constant, H	2.129 kW.secs/KVA

7. **CAPACITANCE AND SURGE IMPEDANCE** (revision in accordance with test)

7.1	Capacitance per phase of stator winding to earth	0.47 microFarad
7.2	Surge impedance per phase	32 Ohms

8. **EXCITATION**

A) **No load (cold):** (revision in accordance with test)

8.1	Excitation current at no load, rated voltage	370 Amps
8.2	Excitation voltage at no load, rated voltage	82 Volts
8.3	Exciter field current at no load (high resistance selection) Exciter field current at no load (low resistance selection)	2.84 Amps N/A Amps
8.4	Exciter field voltage at no load (high resistance selection) Exciter field voltage at no load (low resistance selection)	21.85 Volts N/A Volts

B) **Rated load (hot):** (revision in accordance with test)

8.5	Excitation current at rated load and P.F.	862 Amps
8.6	Excitation voltage at rated load and P.F.	252 Volts
8.7	Exciter field current at rated load and P.F. (high resist. selection) Exciter field current at rated load and P.F. (low resist. selection)	7.95 Amps N/A Amps
8.8	Exciter field voltage at rated load and P.F. (high resist. selection) Exciter field voltage at rated load and P.F. (low resist. selection)	80 Volts N/A Volts

C) **Short circuit clearance of 2.2 p.u rated line amps (hot):** (revision in accordance with test)

8.9	Excitation current on clearance	1263 Amps for 10 sec
8.10	Excitation voltage on clearance	369 Volts
8.11	Exciter field current on clearance (high resistance selection) Exciter field current on clearance (low resistance selection)	11.65 Amps N/A Amps
8.12	Exciter field voltage on clearance (high resistance selection) Exciter field voltage on clearance (low resistance selection)	118 Volts N/A Volts

9. **INHERENT VOLTAGE REGULATION** (revision in accordance with test)

9.1	F.L to N.L rated P.F., constant excitation	42 %

The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

9.2	F.L to N.L unity P.F., constant excitation	32 %
9.3	F.L to N.L steady state under full AVR control	± 0.5 %

BRUSH ELECTRICAL MACHINES LTD

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

10. EXCITER

10.1	Exciter frame size	HA 412422/6
10.2	Voltage rating	256 Volts D.C
10.3	Current rating	934 Amps D.C
10.4	Output	239 kW
10.5	Frequency.	180 Hz
10.6	AC voltage at full load	200 Volts RMS
10.7	AC current at full load	715 Amps RMS
10.8	Power factor	0.97
10.9	Number of phases	3
10.10	Excitation System Voltage Response Time	0.3 $secs^{-1}$

11. ROTATING RECTIFIER

11.1	Number of diodes	12
11.2	Arrangement	3 ph full wave bridge; 6 arms; 2 diodes in series
11.3	Diode Repetitive peak reverse voltage	3800 Volts
11.4	Diode rated mean forward current	1620 Amps
11.5	Diode mean forward current at rated load	335 Amps
11.6	Diode reverse voltage at rated load	276 Volts

12. PERMANENT MAGNET PILOT EXCITER (revision in accordance with test)

12.1	Pilot exciter frame size	X 422260/16
12.2	Open circuit volts (high voltage PMG selection) Open circuit volts (low voltage PMG selection)	N/A Volts 276 Volts
12.3	Short circuit current (high voltage PMG selection) Short circuit current (low voltage PMG selection)	N/A Amps 110 Amps
12.4	Full load voltage (high voltage PMG selection) Full load voltage (low voltage PMG selection)	N/A Volts 250 Volts
12.5	Full load current(high voltage PMG selection) Full load current(low voltage PMG selection)	N/A Amps 24 Amps
12.6	Power factor	—
12.7	Rated frequency	480 Hz

The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

12.8	Number of phases	1

ELECTRICAL DATA SHEET - CONTINUATION

BDAX 98-330ER, 108.190 MW, 0.850 pf, 13.80 kV, 60 Hz

13. MISCELLANEOUS GENERATOR DATA (revision in accordance with test)

13.1	X/R ratio	176
13.2	Synchronising coefficient	97 MW/radian
13.3	No load synchronising power	160 MW/radian
13.4	Full load synchronising power	145 MW/radian
13.5	Damping torque coefficient	42 p.u.
13.6	Magnetic centering force for an axial displacement of 20 mm	694 kg
13.7	Motoring power	1102 kW
13.8	Saturation factor	1.45

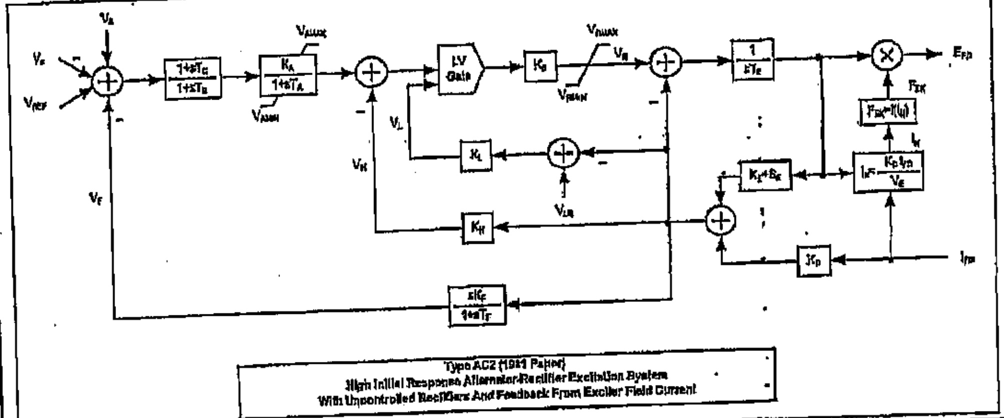
The electrical details provided are calculated values. Unless otherwise stated, all values are subject to tolerances as given in the relevant national standards. The rotor inertia value may vary slightly with generator/turbine interface. In the event of conflict, the figure quoted on the rotor geometry drawing takes precedence.

Excitation System Model , Brush 98-330ER 60 Hz Generator - Intro Rating

Generator Manufacture	Brush	Rating	108.19	MW	0.85	PF
Generator Model	98-330ER	Supply	13.8	kV	60	Hz
Exciter	HA412422/6	Pilot Exciter	X422260/16			

Reference: IEEE Transactions on Power Apparatus and Systems
Vol. PAS-100, No. 2, February 1981, Page 494-509

Transfer Function Diagram



Generator / Exciter Parameters

V_{FE}		1 per unit exciter field voltage on air gap line (hot)	16.80	volts
R_F		Exciter field resistance (hot)	11.20	ohms
V_S		PMG open circuit A.V.R. supply voltage at 100% speed	300.00	volts
E_{FD}		1 p.u. Exciter output voltage	107.00	volts
E_{FDMAX}		Maximum exciter ~~output~~ output voltage	297.00	volts
T_E		Exciter field time constant	0.80	sec
K_E		Exciter constant	1.00	
$S_{E(E1)}$		Exciter saturation function at 75% ceiling voltage (26.5 A base)	0.123	
E1	713,45 V	75% ceiling voltage	6.67	p.u.
$S_{E(E2)}$		Exciter saturation function at 100% ceiling voltage (26.5 A base)	1.007	
E_2	951,26 V	100% ceiling voltage	8.89	p.u.
K_D		Demagnetizing factor (function of exciter reactance)	1.30	
K_C		Rectifier loading factor	0.10	
E_{FD}		Rotor voltage at full load (hot)	233.00	volts
I_{FD}		Rotor current at full load (hot)	850.00	amps

Automatic Voltage Regulator Parameters

IEEE Definition of 1981 Model	AC2
Regulator Type	Salem EX2100
Minimum Design Response Ratio	0.3

TA	AVR Time Constant	0.01	
TB	Lag Time Constant	1.00	
TC	Lead Time Constant	1.00	
TE	Exciter Time Constant	1.16	sec
TF	Rate Fedback Time Constant	1*	
TR	AVR Input Filer Time Constant	0.01	
KA	AVR Gain	1000*	
KB	Gain	1.00	
KE	Self Excited Field Constant	1.00	
KF	Rate Feedback Gain	0.05*	
KH	Exciter Field Current Compensation	0.00	
KL	Exciter Field Current Limit Gain	[illegible].00	
VLR	Exciter Field Current Limit Setpoint	8.30	
VAMAX	Maximum Internal AVR Voltage	[illegible]1.50	
VAMIN	Minimum Internal AVR Voltage	[illegible]1.50	
VRMAX	Maximum Ouput Regulator	[illegible]27.00	
VRMIN	Minimum Ouput Regulator	[illegible]27.00	
EFDMAX	Voltage at Saturation Point	[illegible]1.98	

SEMAX	Saturation Factor	[illegible]	
EFD 0.75MAX	Voltage At 0.75 of Saturation Point	[illegible]	
SE 0.75 MAX	Saturation Factor	[illegible]	

* Typical Settings

REV	DESCRIPTION
A	REVISED PER ECO

DRAWING NO	
REVISION	A
SHEET	1 of 1

107 generator rotor volts at rated voltage on the gen. air gap line, hot gen. field resistance (82 V - cold resistance)
296,8=11.2*26,5,filled according to your formula

Saturation fucntions at 26.5 A @ (11,05-9,84)/9,84=(C-B)/B
Saturation fucntions at 26.5 A
Saturation fucntions at 26.5 A @ (26.5-13.21)/13.21=(C-B)/B
Saturation fucntions at 26.5 A

GE DYNAMIC MODELS

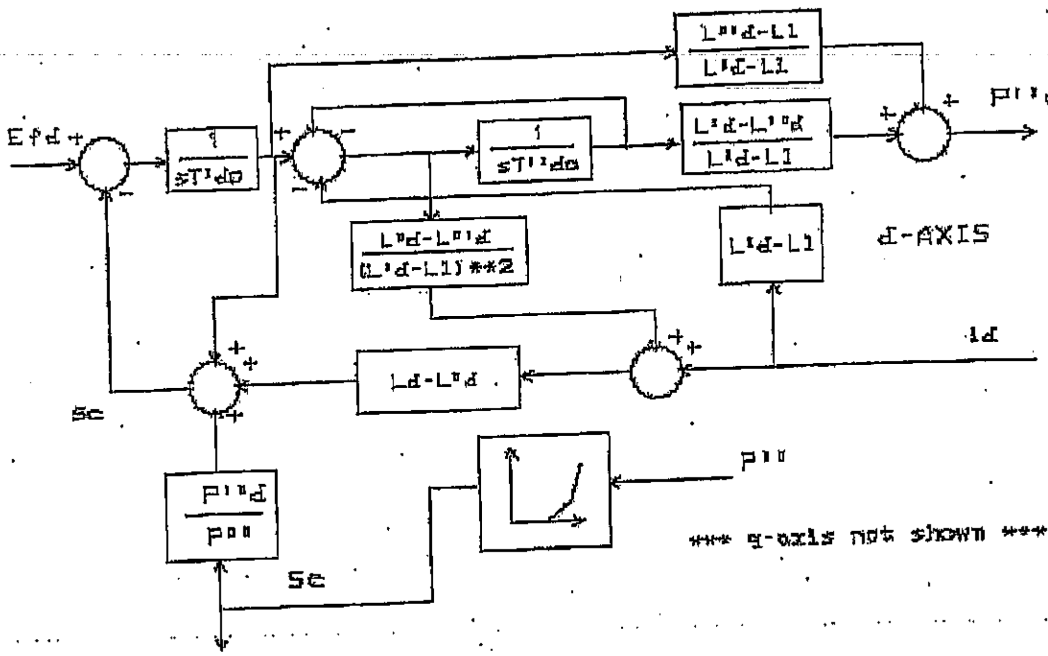
Generator:

Model Name: genrou

Description: Solid rotor generator represented by equal mutual inductance rotor modeling

Parameters:

Name	Epcl Variable	Description	Value
T'do	tpdo	D-axis transient rotor time constant	10.6 seconds
T"do	tppdo	D-axis sub-transient rotor time constant	0.04 seconds
T'qo	tpqo	Q-axis transient rotor time constant	3.8 seconds
T"qo	tppqo	Q-axis sub-transient rotor time constant	0.042 seconds
H	h	Intertia constant sec	2.129 kW.secs/KVA
D	d	Damping factor pu	42 p.u.
Ld	ld	D- axis synchronous reactance	155.5%
Lq	lq	Q- axis synchronous reactance	134.6%
L'd	lpd	D- axis transient reactance	18.55%
L'q	lqd	Q- axis transient reactance	24.8%
L"d	lppd	D- axis sub-transient reactance	12.08%
Ll	ll	Stator Leakage reactance, pu	9.53 %
Se (1.0)	S1	Saturation factor at 1pu flux	1.45
Se (1.2)	S12	Saturation factor at 1.2pu flux	
Ra	ra	Stator Resistance, pu	0.00085 ohms /phase
Rcomp	rcomp	Compounding resistance for voltage control, pu	
Xcomp	xcomp	Compounding reactance for voltage control, pu	


Efd
1
sT'do
1
sT''do
L''d-Ll
L'd-Ll
L'd-L''d
L'd-Ll
L'd-L''d
(L'd-Ll)**2
L'd-Ll
P''d
d-AXIS
id
Ld-L'd
Se
P''
P''d
P''
Se
*** q-axis not shown ***

Exciter:

Model Name: exac2

Description: IEEE type AC2 excitation system

Parameters:

Name	Epcl Variable	Description	Value
Tr	tr	Filter time constant, sec	0.01
Tb	tb	Time constant, sec	1.00
Tc	tc	Time constant, sec	1.00
Ka	ka	Voltage regulator gain	1000
Ta	ta	Time constant, sec	0.01
Vamax	vamax	Maximum control element output, p.u.	11.5
Vamin	vamin	Minimum control element output, p.u.	-11.5
Kb	kb	Exciter field current controller gain, p.u.	1.00
Vrmax	vrmax	Maximum exciter control signal, p.u.	27.00
Vrmin	vrmin	Minimum exciter control signal, p.u.	-27.00
Te	te	Exciter time constant, sec	1.16
Kl	kl	Exciter field current limiter gain, p.u.	4.00
Kh	kh	Exciter field current feedback gain, p.u.	0.00
Kf	kf	Rate feedback gain, p.u.	0.05
Tf	tf	Rate feedback time constant, sec	1
Kc	kc	Rectifier regulation factor, p.u.	0.10
Kd	kd	Exciter internal reactance, p.u.	1.30
Ke	ke	Exciter field resistance constant, p.u	1.00
Vlr	vlr	Maximum exciter field current, p.u.	18.30
E1	e1	Field voltage value, 1	1.98
Se (E1)	se1	Saturation factor at E1	0.00
E2	e2	Field voltage value, 2	1.38
Se (E2)	se2	Saturation factor at E2	0.00

Block Diagram attached.

Power System Stabilizer:

Model Name: pss2a

Description: Dual input Power system stabilizer (IEEE type PSS2A)

Data sheet attached

Turbine- Governor:

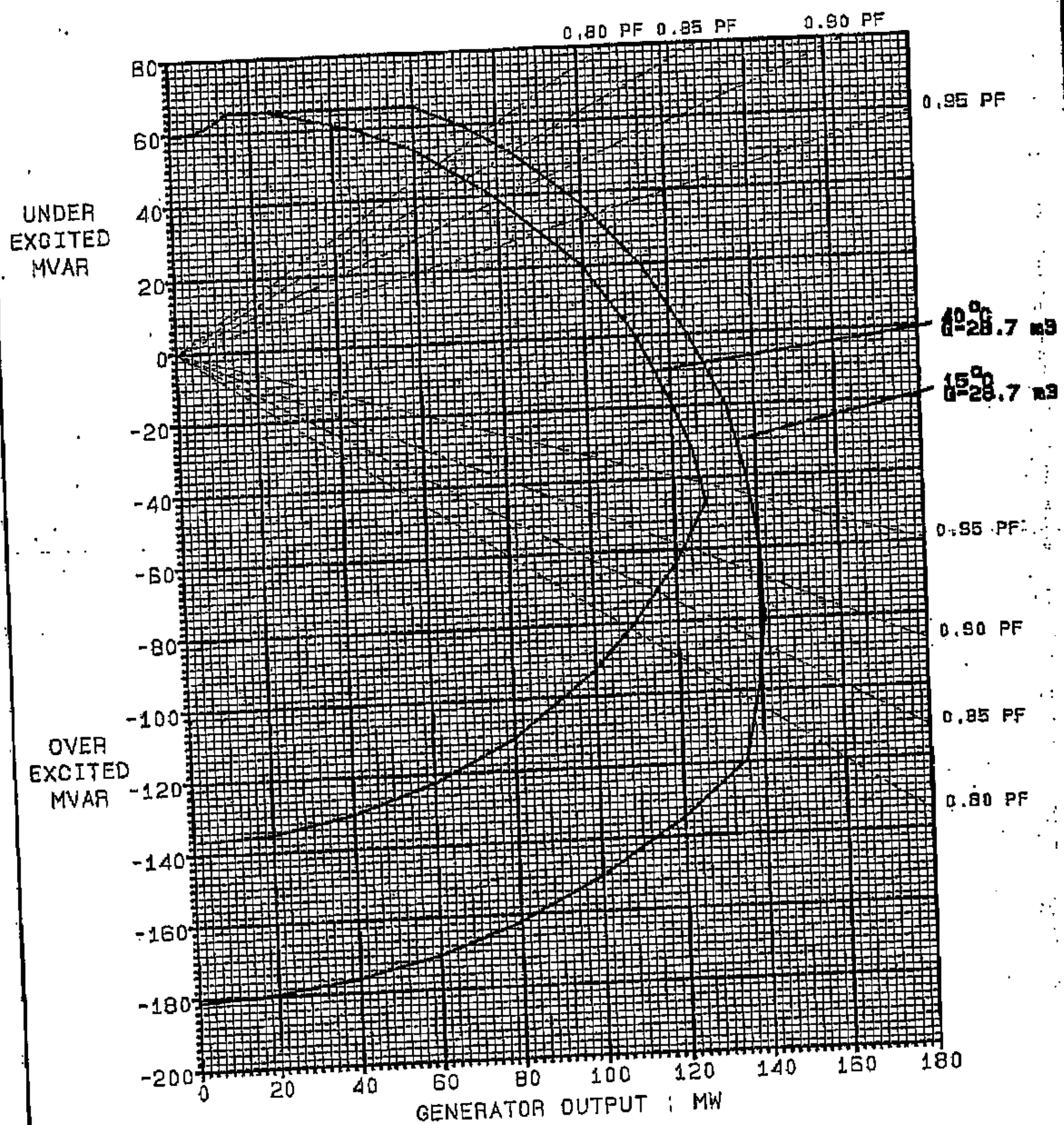
Model Name: ieeeg1

Description: IEEE steam turbine/governor model (with deadband and nonlinear valve gain added)

Data sheet attached

BRUSH ELECTRICAL MACHINES LTD. H.E.P 19907

GENERATOR CAPABILITY DIAGRAM



BDAX 98-330ER
13.80KV, 3Ph, 60 Hz.

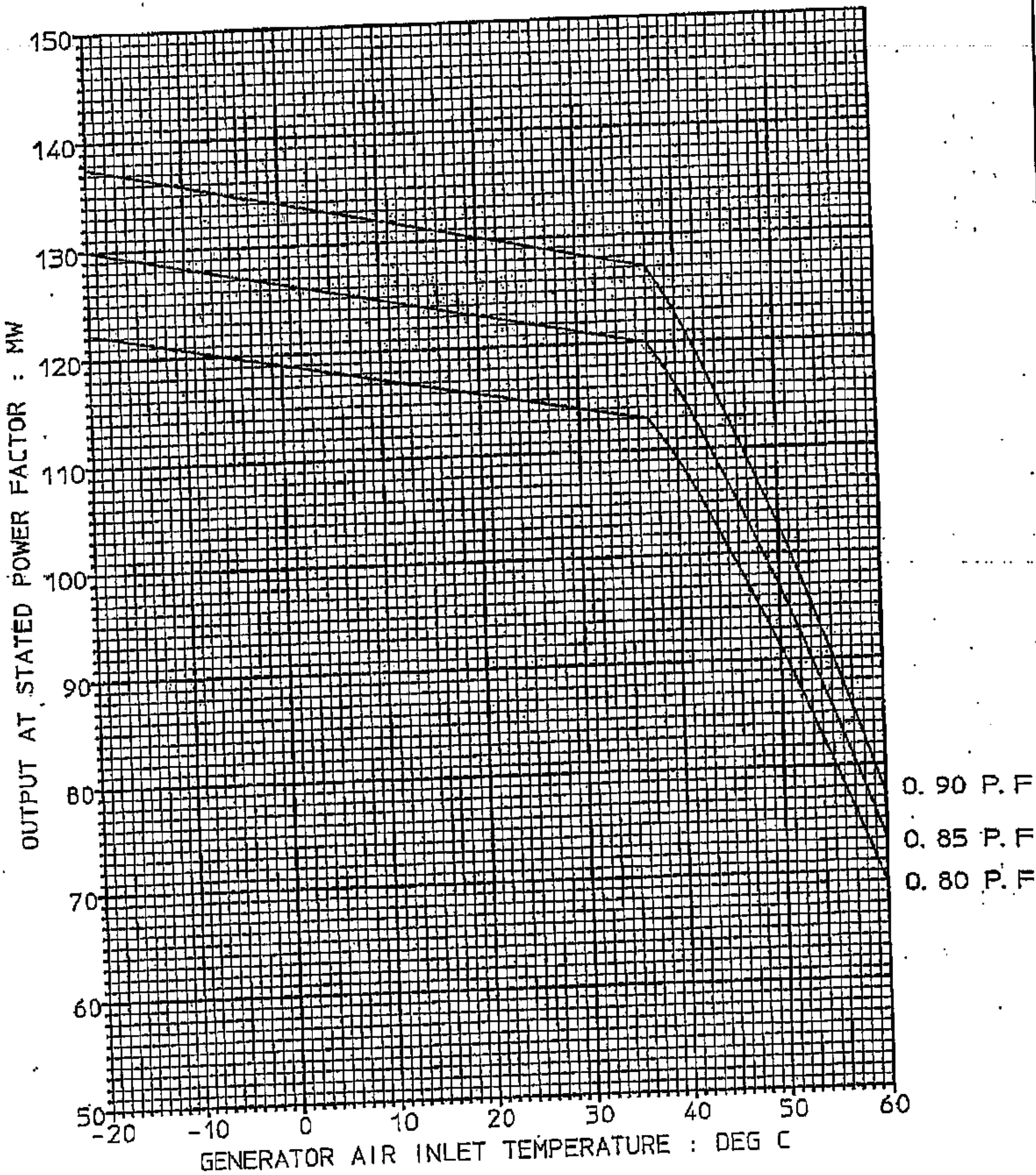
Up to 1000. meters ASL

IN ACCORDANCE WITH
ANSI C50.14
Class B temperatures.
Total temperatures Stator 110 Deg C
Rotor 125 Deg C

Issue No. 2: 26-August-2004

BRUSH ELECTRICAL MACHINES LTD.

VARIATION OF GENERATOR OUTPUT WITH AIR INLET TEMP



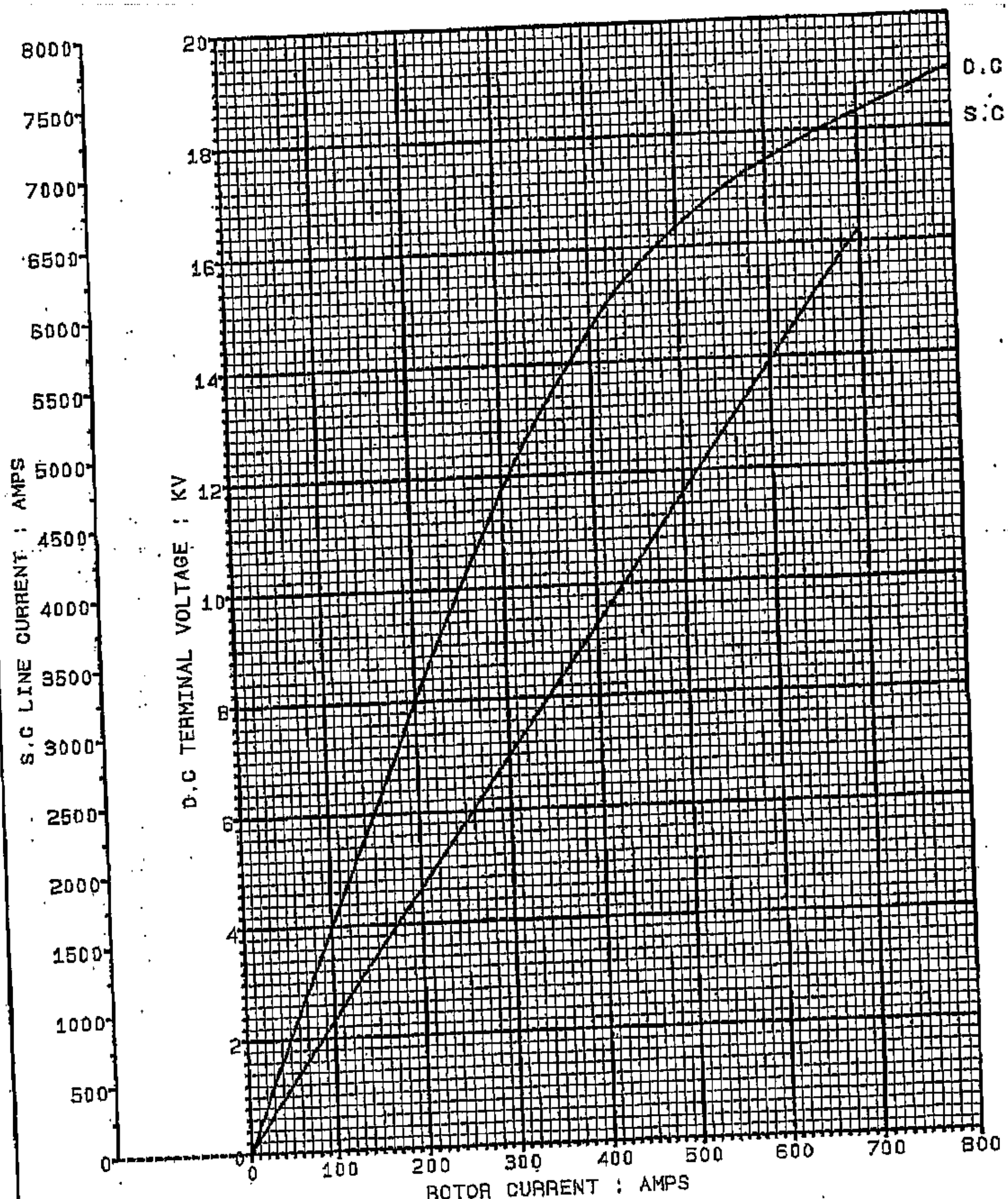
BDAX 98-330ER
13. 80KV, 3Ph, 60. Hz.
Q = 28. 7 m3/s
Up to 1000. meters ASL

IN ACCORDANCE WITH
ANSI C50. 14
Class B temperatures.
Total temperatures Stator 110 Deg C
Rotor 125 Deg C

Issue No. 2: 26-August-2004

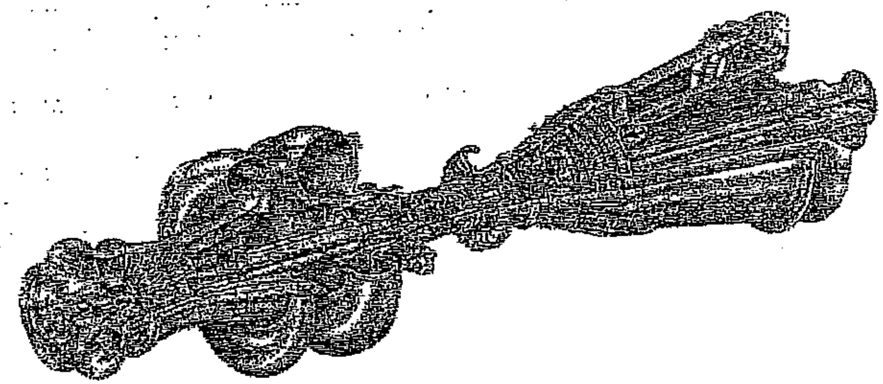
BRUSH ELECTRICAL MACHINES LTD.

OPEN CIRCUIT AND SHORT CIRCUIT CHARACTERISTIC



BDAX 98-330ER
3Ph, 60.Hz, 3600, RPM.

Issue No. 2: 26-August-2004



LMS100 Simplified Grid Dynamic Model (preliminary)

The information contained in this document is from the GEAC preliminary transient simulation (lms100.fsim) of the LMS100 gas turbine and control. The gas turbine is represented by a Component Level Model (CLM) that models the primary engine components (compressor, combustor, turbines, etc.). The control model is based on a GE preliminary control definition and simulates the digital control, sensors, actuators fuel metering system and inter-cooler.

THE MODEL PROVIDES ESTIMATED TRANSIENT PERFORMANCE BUT DOES NOT PROVIDE PERFORMANCE GUARANTEES

Peter Harrison

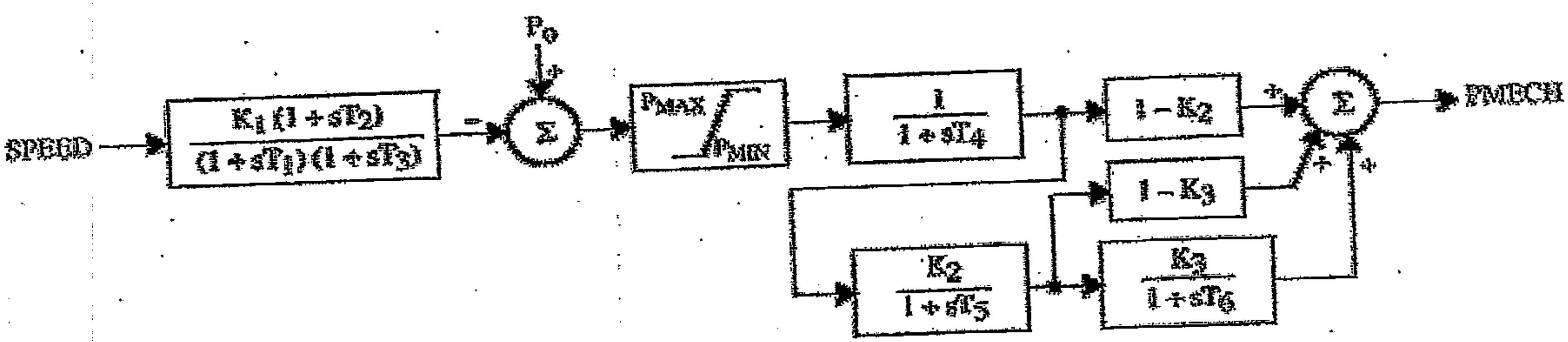
April 23, 2004

GE imagination at work

IEESGO

IEEE Standard Governor

This model is located at system bus	#______	IBUS,
machine	#______	I.
This model uses CONs starting with	#______	J,
and STATEs starting with	#______	K,
and VAR	#______	L.



Turbine

GE Transportation – Aircraft Engines
Peter Hardison
April 23, 2004

leeeg1

CONs	#	Value	Description
J		25.2	T_1, controller lag (sec) ✓
J+1		0.01	T_2, controller lead compensation (sec) ✓
J+2		0.01	T_3, governor lag (>0) (sec) ✓
J+3		0.01	T_4, delay due to steam inlet volumes associated with steam chest and inlet piping (sec) ✓
J+4		0.01	T_5, reheater delay including hot and cold leads (sec) ✓
J+5		0.01	T_6, delay due to IP-LP turbine, crossover pipes, and LP end hoods (sec) ✓
J+6		24.00	K_1, 1/per unit regulation ✓
J+7		0.0	K_2, fraction ✓
J+8		0.0	K_3, fraction ✓
J+9		1.2	P_{MAX}, upper power limit ✓
J+10		0.8	P_{MIN}, lower power limit ✓

STATEs	#	Description
K		Filter output
K+1		Valve or gate servo output
K+2		Turbine powers
K+3		Turbine powers
K+4		Turbine powers

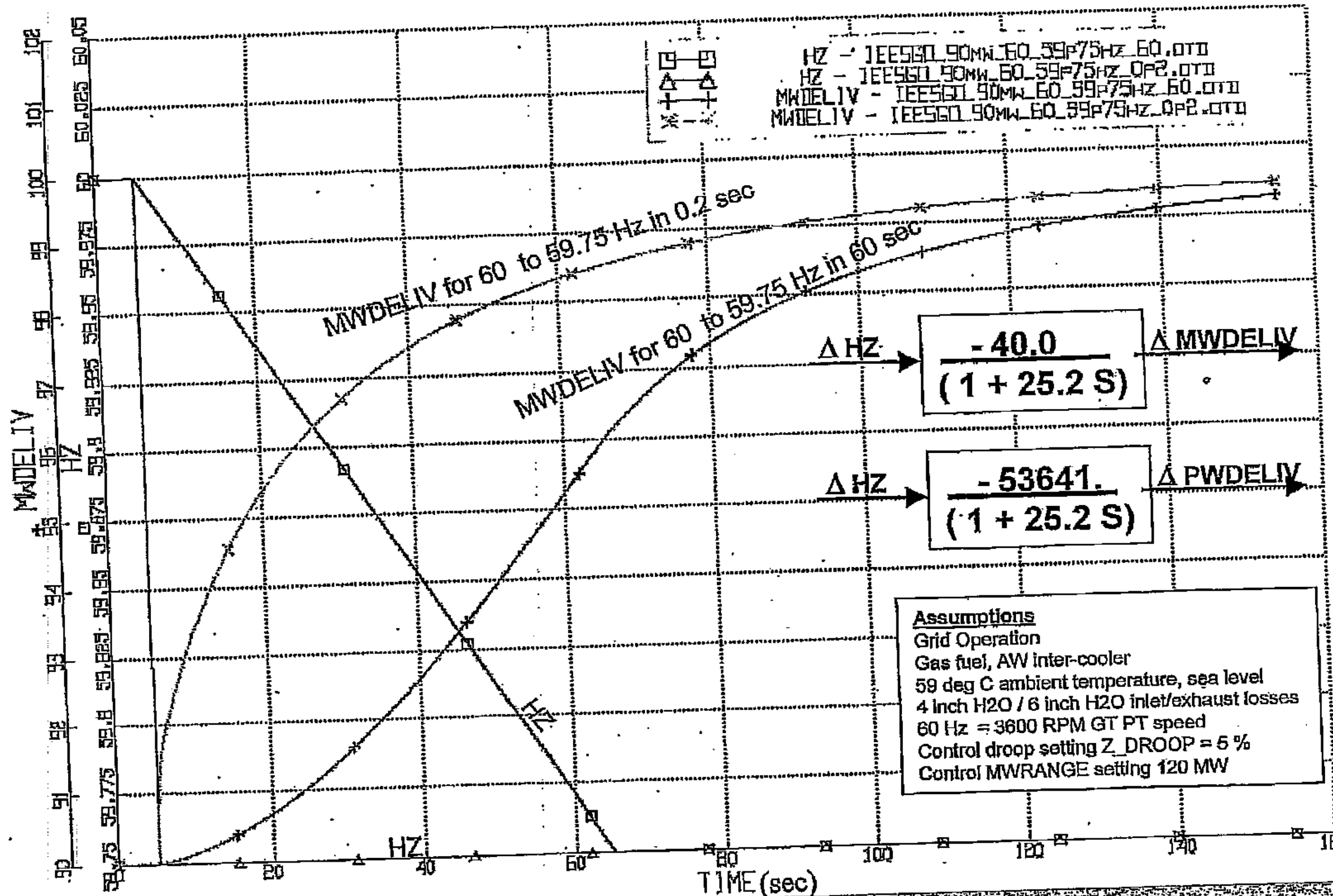
VAR	#	Description
L		Reference, P_0

ASSUMPTIONS

1. Values for constants are set to duplicate LMS100 transfer function as specified on sheet 2. Constants do not match the Descriptions as specified in table.
2. SPEED is PT rotor deviation from nominal in rpm/3600
3. Pmech is delivered power in horsepower/134102

IBUS, 'IEESGO', I, T_1, T_2, T_3, T_4, T_5, T_6, K_1, K_2, K_3, P_{MAX}, P_{MIN}/

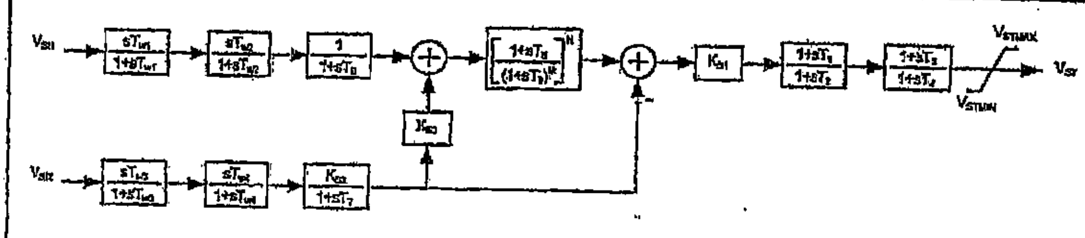
LMS100 Grid frequency ramped 60 to 59.75 Hz over 60 sec period
60 to 59.75 Hz over 0.2 sec period
90 MW initial power



Assumptions
Grid Operation
Gas fuel, AW inter-cooler
59 deg C ambient temperature, sea level
4 inch H2O / 6 inch H2O inlet/exhaust losses
60 Hz = 3600 RPM GT PT speed
Control droop setting Z_DROOP = 5 %
Control MWRANGE setting 120 MW

IEEE PSS2A Model Constants			
Customer	TBA		
Alternator	Brush 98-300ER		
Unit	LMS100 Gas Turbine Generator		
Prepared by	R Kleen		
Date	June 1, 2004		
Comment	Model for PSS Tuning Study for EX2100 AVR		
VS1	Machine Speed (pu)		
VS2	Electrical Power (pu)		
		Prelimanary Value	Suggested Range
TW1	Washout Time Constant	2.000	2 - 15
TW2	Washout Time Constant	2.000	2 - 15
TW3	Washout Time Constant	2.000	2 - 15
TW4	Washout Time Constant	0.000	0
T1	1st Lead Time Constant	0.150	0.1 - 2
T2	1st Lag Time Constant	0.030	0.01 - 1
T3	2nd Lead Time Constant	0.150	0.1 - 2
T4	2nd Lag Time Constant	0.030	0.01 - 1
T6	Filter Time Constant	0.000	0
T7	Filter Time Constant	2.000	2 - 15
T8	RTF Numerator	0.500	5 x RTF Denominator
T9	RTF Denominator	0.100	0.01 - 40
N	RTF Order	1.000	1
M	RTF # Poles	5.000	5
KS1	PSS Gain	15.000	0-100
KS2	Inertia Gain (=Tw/2H)	0.237	Tw/(2H)
KS3	Pe Gain	1.000	1
VSTmax	Positive Output Limit (pu)	0.100	0.02 - 0.1
VSTmin	Negative Output Limit (pu)	-0.100	-0.02 - -0.1

The data on this sheet is **GENERIC** and should **NOT** be used with equipment in the field.
Such data should only come from tuning studies which determine the optimal PSS settings.



IEEE Type PSS2A Dual Input Stabilizer Model